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ON THE LINGUAL DENTITION AND SYSTEMATIC POSITION OF PYRGULA.

BY C. E. BEECHER.

(*Read November 1st*, 1889.)

The genus *Pyrgula* has been so often assigned to various families of the mollusca by different authors, that it has had a truly remarkable experience. There now seems to be about an equal weight of opinion as to whether it should be placed in the family Rissoidæ or among the Melaniidæ. Without more definite information than that expressed by the shell, it appears merely a matter of choice as to which group should include the genus. This condition is but one of many, in which development in parallel lines produces forms having great similarity in external appearance, and in which recourse must be had to more important and reliable characters than external form, in order to ascertain their true systematic position.

True systematic data should, if possible, be based upon the assemblage of all the characters of the organism, and it is unsafe to take any one as infallible. In the present genus —*Pyrgula*, and among many similar small turreted and globular shells, as the Rissoidæ, which commonly vary within narrow limits, any important member of the animal which exhibits great

Explanation of Plate 21.

(*a*) Two members of the radula with the teeth in their normal position.

(*b*) The teeth of the second or outer pleural series; showing their spoon-like form

(*c*) The teeth of the first pleural series; carrying eighteen denticles each.

(*d*) The lateral teeth; showing the long slender peduncle, the quadrate body with an alveolus, and the curved serrula bearing ten denticles.

(*e*) Two of the rachidian teeth; showing their form and the arrangement of the denticles.

All figures magnified 500 diameters.

differentiation and is more diversified than the shell, naturally affords a more convenient and trustworthy basis for systematic determination.

Too great reliance may be often placed upon trivial differences in the lingual dentition, but it is believed that within reasonable limits, the characters of the odontophore are extremely serviceable for purposes of classification. Especially is this true for family distinctions, and on this account, such features are commonly recognized as of much, though not of sole, importance

The radula in the Rissoidæ is very characteristic, its principal diagnostic feature being the presence of basal denticles on the rachidian teeth. The accompanying illustration and description of this organ in *Pyrgula annulata*, C. & Jan. (*P. helvetica*, Mich.) the type species of the genus, show that basal denticles are not present on the rachidian tooth, and, therefore, it cannot properly be arranged with the Rissoidæ, but is related to the Melaniidæ.

The genus is at present unknown in North America, as the species which were originally ascribed to it have since been placed in other genera. The first American species thus referred was *Pyrgula scalariformis*, Wolf. (Am. Jour. Conch., vol. v. p. 198, pl. 17, f. 3, 1870) from the Post Pliocene of the Illinois river. This form is now believed to belong to the genus *Pyrgulopsis*, Call and Pilsbry.[1] In 1883, R. E. C. Stearns described a shell from Pyramid Lake, Nevada, and placed it in *Pyrgula* (*P. nevadensis*). The dentition of this form was described and figured by the writer in 1884,[2] but as, at that time, the true dentition of *Pyrgula* was unknown, no comparisons could be drawn, and the systematic position of the species remained unchallenged. Subsequently Call and Pilsbry (*loc. cit.*) proposed the genus *Pyrgulopsis* for this and allied species based upon conchologic features. The only difference in the shell noted is that *Pyrgula* is bicarinate or multicarinate, while *Pyrgulopsis* is characterized as a unicarinate form.

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[1]On Pyrgulopsis, a new genus of Rissoid mollusk, with descriptions of two new forms. Proc. Davenport, Acad. Nat. Sci., Vol. V. 1886.

[2]Call and Beecher. Notes on a Nevada shell (*Pyrgula nevadensis*). *American Naturalist*, vol. xviii., pp. 853, 854. 1884.

PYRGULA, Christofori and Jan, 1832.

Type, *Melania helvetica*, Michelin, 1831.
= *Pyrgula annulata*, Christ. & Jan, 1832.

Lingual dentition. The number of longitudinal rows of teeth is seven, arranged 3-1-3, after the formula (15-18-10)-15-(10-18-15).

The rachidian tooth is longitudinally semi-elliptical, with the sides nearly at right angles to the line of the base. Serrula abruptly curving forward, and bearing about fifteen denticulations. The central denticle is the largest and most prominent. The lateral series diminish rapidly in descending order, so that the denticles on the sides of the tooth are very small.

Body of lateral tooth subquadrate, with an angular projection at the basal margin, and a subovate thin alveolus in the central portion. Peduncle slender. Serrula with ten denticles; the fourth from the inner end of the series is much the largest.

The first pleural has about eighteen denticles on the serrula. The second is spoon-shaped, and bears about fifteen denticles.

The shell from which the radula was obtained for this description is from Italy. It was kindly furnished the writer by Wm. H. Dall, Honorary Curator Department of Mollusks, U. S. National Museum.

AMPLIFICATION IN MICROMETRY.

BY HON. MARSHALL D. EWELL, LL. D.

(*Read December 20th*, 1889.)

My attention has quite recently been drawn to this subject in connection with the celebrated "Dr. Cronin case." It may be taken for granted that one cannot measure what he cannot see· But how high an amplification is necessary in a given case is a matter of much importance. In the measurement of blood-corpuscles in medico-legal cases the late Dr. Richardson advocated the use of a very high power, viz.: a $\frac{1}{25}$ or $\frac{1}{50}$ objective. In my own measurements of blood-corpuscles I have out of respect to authority, always used a high power, from 1,500 to 1,800 diameters. Recent experience has, however, qualified my views upon the subject, and in the case of the comparison of the ultimate subdivisions of a micrometer, ruled on metal, I am now of the opinion, that practically the same result may be obtained by the use of a $\frac{1}{4}$ objective as with a $\frac{1}{18}$ or $\frac{1}{25}$.

In December, 1885, I commenced the investigation of the $\frac{1}{100}$ mm. spaces of "Centimeter A." ; but was unable to finish it. Two series of measurements were then made with a Bausch & Lomb opaque illuminating objective, and a Bullock filar micrometer. Recently I have measured the same spaces with a Spencer $\frac{1}{10}$ and $\frac{1}{25}$, and with a Zeiss $\frac{1}{18}$. The results of these measurements are given in the table below, each correction being the mean of from three to twelve readings of the filar micrometer at each end of the measured space.

It will be observed that the agreement between the several series of the writer and the results obtained by Prof. Hilgard is quite close, the discrepancy being practically insensible.

Provided the amplification is sufficient to render the object to be measured of a sensible size, and to render the difference between the sizes of two objects visible, my own judgment is that little, if anything, is gained by the use of a power so high as to impair the definition, even though such impairment be but slight. Quite as much, in other words, is lost by impairment of definition as is gained by increase of amplification. The practical conclusion then is that no higher power should be used than is consistent with perfect definition.

Table of Measurements of "Centimeter A."

Date.	Objective.	Value of 1 div. of mic.	2d $\frac{1}{10}$ mm.	3d	4th	5th	6th	7th	8th	9th	10th	11th	Remarks.
Dec. 26 and 27, 1885.	$\frac{1}{4}$ Bausch & Lomb.	0.126 μ	+0.38 μ	−0.01 μ	+0.05 μ	−0.39 μ	+0.14 μ	+0.27 μ	−0.14 μ	−0.12 μ	+0.09 μ	−0.26 μ	Bullock filar micrometer and Smith's vert. illuminator.
Sept. 12, '89	$\frac{1}{18}$ Zeiss.	0.01651 μ	+0.36	+0.02	+0.06	−0.42	+0.15	+0.28	−0.25	−0.07	+0.08	−0.21	Zentmayer filar micrometer and Smith's vert. illum.
" "	"	0.02166 μ	+0.33	0.00	+0.04	−0.41	+0.15	+0.25	−0.22	−0.14	+0.20	−0.22	Bullock filar micrometer and Smith's vert. illuminator.
Sept. 15, '89	$\frac{1}{25}$ Spencer.	0.02071 μ	+0.31	−0.05	+0.05	−0.43	+0.17	+0.32	−0.21	−0.06	+0.11	−0.19	Bullock filar micrometer and Smith's vert. illuminator. Collar correction = 10°.5.
" 18, '89	$\frac{1}{10}$ "	0.0401 μ	+0.32	+0.03	+0.03	−0.49	+0.16	+0.27	−0.18	−0.16	+0.20	−0.18	Bullock filar micrometer and Smith's vert. illuminator. Collar correction = 2 Rev. 0.¾.
" 19, '89	$\frac{1}{10}$ "	0.02561 μ	+0.36	−0.01	0.00	−0.47	+0.17	+0.25	−0.23	−0.05	+0.16	−0.18	Bullock filar, Smith's vert. illuminator and Bausch & Lomb amplifier. Cover correc. = 2 Rev. 0.¾.
		Mean.	+0.34	0.00	+0.04	−0.44	+0.16	+0.27	−0.22	−0.10	+0.15	−0.20	
Correction for error of total length..			+0.02	+0.02	+0.02	+0.02	+0.02	+0.02	+0.02	+0.02	+0.02	+0.02	This is $\frac{1}{10}$th correction for the 1st $\frac{1}{10}$ mm. = + 0.20 μ.
Total correction....................			+0.36	+0.02	+0.06	−0.42	+0.18	+0.29	−0.20	−0.08	+0.16	−0.19	
Correction for same spaces as per report of Professor Hilgard......			+0.34	+0.05	+0.09	−0.41	+0.20	+0.39	−0.19	−0.05	+0.20	−0.18	

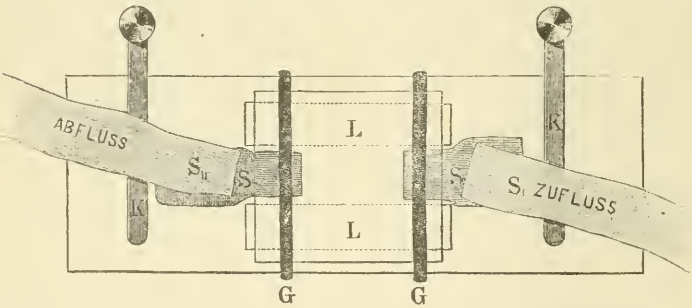
ON CULTIVATING LIVING ORGANISMS UNDER THE MICROSCOPE.

BY E. A SCHULTZE.

[Abstract and translation from an Article by Dr. John af Klercker in *Zeitschrift für Wissenschaftliche Mikroskopie*, vi. 2, p. 145 (1889).]

(*Read October* 18*th*, 1889.)

Any one, at all familiar with the microscopical study of living organisms, will have met with the difficulty of making a satisfactory examination, on account of the globular shape of the liquid containing the culture. It is well known that, in order to bring the objects to a full state of development, the water, especially in the case of algæ, must often be changed.

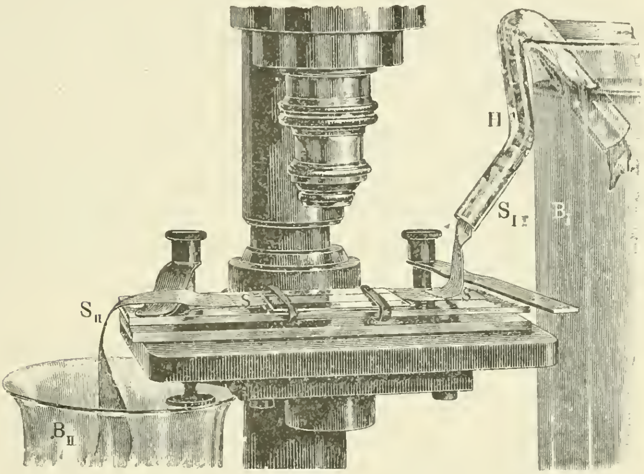


1

In doing this, it is in most cases difficult to prevent the algæ from changing their position under the cover-glass. Consequently a filament under observation may be lost to view. Sometimes, when a too sudden evaporation is feared, the volume of the drop must be increased to such extent that the high-power objectives, and especially the homogeneous immersion lenses, can only be used on those filaments which lie nearest to the cover-glass.

To obviate this difficulty I have been using an apparatus, the construction of which admits of a constant flow of water, and I find that it answers to my entire satisfaction in every

particular. Two strips, of equal length and breadth, say one inch long and one-quarter of an inch wide, cut from the ordinary square thin cover-glass, are cemented to a slide with Canada-balsam, as seen in Fig. 1, L, L. The object is now placed in a large drop of water between these two strips, under a one inch square cover-glass, and the entire capillary space



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may be filled, if necessary, by adding a few more drops of water.

Two short strips of linen, S, S, are now inserted, one at each end, and are held in position by two rubber bands, passing over the cover-glass and around the slide. In order to secure a flat surface on the under side, the slide is now cemented to another slide by means of two pieces of wax, equal in diameter to that of the rubber bands.

A glass (Fig. 2 B, 1.), reaching about three inches above the stage of the microscope, is filled with water, and a glass siphon inserted, the shorter arm of which has a much smaller opening than the longer. After filling the siphon with water, a strip of linen is gradually forced into the longer arm, till the flow of water is reduced to dropping. The linen strip is now cut the required length, and connected with one of the short pieces at

the side of the cover-glass. The water glass may be covered, to exclude any particles of dust. In this way a constant and steady flow of water is secured. The over-flow is carried, by means of another linen strip, from the opposite end of the cover-glass into a small receptacle at the foot of the microscope.

The following are the advantages of the apparatus :

1. A constant flow of fresh water, which may be regulated by the linen strip in the siphon. The water, while running, keeps saturated with oxygen, by means of the linen strip extending from the mouth of the longer arm of the siphon. This strip also acts as a filter, retaining any particles of dust, that may have accumulated in the reservoir.

2. The height of the capillary space between the cover-glass and the slide being only of the thickness of an ordinary cover-glass, all objects may easily be seen with an immersion lens.

3. The immersion fluid may be removed from the cover-glass without disturbing the objects.

PROCEEDINGS.

Meeting of October 4th, 1889.

The President, Mr. Charles F. Cox, in the chair.

Thirty persons present.

The Recording Secretary read a Paper, presented by Mr. P. H. Dudley, and entitled "Note on *Calotermes marginipennis*, Latr." This Paper is published in the Journal, Vol. V., p. 111.

Mr. Stephen Helm, of No. 417 Putnam Avenue, Brooklyn, N. Y., read a Paper, entitled, "Note on the binary subdivision of *Micrasterias denticulata* (Breb.), Ralfs," illustrated by black-board sketches and an exhibit, as announced below. This Paper is published in the Journal, Vol V., p. 93.

OBJECTS EXHIBITED.

1. Spores of the Fungus, *Ustilago utriculosa*, Tul., on *Polygonum Pennsylvanicum*, L.: by J. L. Zabriskie.
2. Spores of the Fungus, *Ustilago Austro-Americana*, Speg., on *Polygonum Pennsylvanicum*, L.: by J. L. Zabriskie.
3. Insect eggs, arranged : by Charles S. Shultz.
4. Transverse section of ovary of the Poppy : by Charles S. Shultz.
5. *Volvox stellatus*, Wolle : by William G. De Witt.
6. Two forms of the same, with changed color : by William G. De Witt.
7. Foot of the Beetle, *Chrysochus auratus* : by F. W. Leggett.
8. Two hairs from the foot of the same : by F. W. Leggett.
9. *Micrasterias denticulata* (Breb.), Ralfs: by Stephen Helm.
10. *Plumatella repens* : by Stephen Helm.
11. *Lophopos crystallinus* : by Stephen Helm.

Mr. Zabriskie stated concerning his exhibits, that these fungi infest the same species of plant, *Polygonum Pennsylvanicum*. *Ustilago utriculosa*, as its specific name indicates, causes the fruit of the host to enlarge like a bladder—externally smooth and of a leaden hue, internally a mass of dark purple spores.

These spores are ornamented with prominent ridges, forming pentagons and appearing at the contour of the spore like the cogs of a gear-wheel. *U. Austro-Americana* affects the fruit, stems and leaves of the host. It sometimes causes the whole spike of the host to become a red, hardened, distorted, varnished mass. The spores are spherical, have the surface furnished with delicate spines, and ooze out in tendrils, which latter are sometimes one-half of an inch in length. This last species was described by Spegazzini, of the Argentine Republic, and was not reported from our Eastern States until these specimens were collected in 1888. Both species were abundant at Flatbush, L. I., in that year, but they have been comparatively scarce during this year.

Mr. Leggett said that his exhibit of the foot of the beetle, *Chrysochus auratus*, showed how the insect is able to walk inverted upon glass. The foot looks like a hair-brush, being furnished with numerous hairs, which are evidently provided at the end with a sucker.

Meeting of October 18th, 1889.

In the absence of the President and the Vice-President, Mr. William Wales was elected President *pro tem.*

Twenty-nine persons present.

Mr. J. Beaumont was elected a Corresponding Member, and Messrs. Henry F. Crosby and Bashford Dean were elected resident members of the Society.

Mr. E. A. Schultze read a Paper, which was an abstract and a translation from an article by Dr. John af Klercker, in *Zeitschrift für Wissenschaftliche Mikroskopie*, vi., 2, p. 167 (1889), entitled "On cultivating living organisms under the Microscope." This Paper was illustrated by black-board sketches, and is published in this number of the Journal, p. 6.

Mr. Schultze also gave an abstract and translation of an article by Dr. S. Apáthy, in the same number of the same publication, p. 171, as follows :

"A NEW CEMENT FOR GLYCERINE MOUNTS.

"In using asphaltum with glycerine mounts, it is preferable, and in most cases necessary, to first prepare a wax cell, which is afterwards covered with the cement, especially if the object

be a larger one than usual. Asphaltum will, moreover, only adhere to well-cleaned glass, and may crack with time. Canada-balsam, which always makes a hard and well-adhering frame, may never dry where it comes in contact with the glycerine, and, if the glycerine layer be not very thin, it will gradually enter under the cover-glass in the shape of a cloudy mass. A glycerine mount framed in Canada-balsam is never safe. It may last for a year or more, but it will eventually deteriorate, as has been my sad experience to witness.

"The cement I have prepared can be used without fear of any of these difficulties occurring. It is composed of equal parts of hard paraffine (melting point 60° C.) and Canada-balsam. They are melted together in a porcelain evaporating dish, and then kept heated over a moderate flame until the mass becomes of a golden color, and emits no more turpentine vapors. When cold the mixture is hard, but it can be readily warmed for use."

Mr. Schultze also gave notice of diatomaceous material found by a fisherman, in the month of June last, floating in the Pacific Ocean, two miles off the coast of Santa Monica, California, and stated that the material was now under examination to ascertain if it contained the same forms as those in the original "Santa Monica Find."

Dr. N. L. Britton read a Paper, entitled "The genus *Eleocharis* in North America." This Paper was illustrated by black-board sketches, and by a series of herbarium specimens and mounts as announced below, and is published in the JOURNAL, Vol. V., No. 4, p. 95.

OBJECTS EXHIBITED.

1. New and old mandibles of *Calotermes marginipennis*, Latr., and cast skin of the nympha of the same. Prepared by J. Beaumont, Colon, S. A.: Exhibited by P. H. DUDLEY.
2. Egg—one day after laying—of *Diplax Berenice*: by L. RIEDERER.
3. Larva of the same, five days old: by L. RIEDERER.
4. Seeds of *Eleocharis mutata* (L.), Rœm. & Schult.: by N. L. BRITTON.
5. Seeds of *E. capitata* (Willd.), R. Br.: by N. L. BRITTON.

6. Pigeon-post film, used in the Franco-Prussian war: by J. D. HYATT.

7. Spores of *Isoetes Englemanni*, Braun: by J. D. HYATT.

MEETING OF NOVEMBER 1ST, 1889.

The President, Mr. Charles F. Cox, in the chair.

Thirty-four persons present.

Mr. Charles S. Shultz introduced to the Society Miss Mary A. Booth, of Longmeadow, Mass., who was present as a visitor.

The President read a Paper, entitled "On the lingual dentition and systematic position of *Pyrgula*," and presented by Mr. Charles E. Beecher, a Corresponding Member of the Society. This paper is published in this number of the JOURNAL, p. 1.

OBJECTS EXHIBITED.

1. Diatoms of the genus *Aulacodiscus*, 29 forms and 19 species; prepared by Möller: by E. A. SCHULTZE.

2. Diatoms of the genus *Aulocodiscus*, 110 forms and 36 species; prepared by Thum: by E. A. SCHULTZE.

3. Fungus affecting shrimp in an aquarium: by F. W. LEGGETT.

4. Diatoms, from Bay of Bengal.

5. Diatoms, from Sandai, Japan.

6. Diatoms, from cementstein of Sandai, Japan.

7. Diatoms, from material found floating two miles off the coast of Santa Monica, California, June, 1889.

8. Diatoms, *Stephanodiscus careonensis* and *Melosira solida*.

9. Diatoms, from Rodondo Beach, California.

These six slides—Nos. 4–9 inclusive—were prepared and exhibited by Miss Mary A. Booth, and were donated by her to the Cabinet of the Society.

On motion, the thanks of the Society were tendered Miss Booth for this donation.

Mr. Leggett stated that he had kept shrimp for the space of four months in an aquarium, and that the fungus exhibited by him was now becoming very destructive to them. Usually a shrimp would die in one night after the appearance of the filaments of the fungus upon its body.

Meeting of November 15th, 1889.

The President, Mr. Charles F. Cox, in the chair.

Forty persons present.

Mr. Charles E. Pellew, E. M., delivered an Address on "The Microscopical and Other Tests for Blood." This Address was illustrated by many chemical experiments, conducted by Mr. Pellew, and by many exhibits, under the direction of Dr. George C. Freeborn and Messrs. G. Müller, C. C. Carmalt and C. F. W. McClure, as announced below.

OBJECTS EXHIBITED.

1. Fresh human blood, in "Holman's Current-slide:" by Charles F. Cox.
2. Circulation of blood in lung of Frog: by Dr. George C. Freeborn.
3. Circulation of blood in mesentery of Frog: by Dr. George C. Freeborn.
4. Human blood in Leucocythæmia, excess of white cells, the number of red cells being reduced by bacteria.
5. Human blood showing *Plasmodium malariæ* in malarial fever.
6. Blood showing *Bacillus* of anthrax.
7. Hæmoglobin crystals from human blood dried six months.
8. Hæmoglobin crystals from fresh blood of White Rat.
9. Blood of Black Bass, double stained.
10. Blood of Robin, double stained.
11. Blood of Frog, double stained.
12. Diluted human blood on a "Blood-cell Counter."
13. Fibrin from fresh human blood.
14. Continuous spectrum.
15. Spectrum of Oxy-Hæmoglobin.
16. Spectrum of reduced Hæmoglobin.
17. Spectrum of Limestone.

Exhibits, Nos. 4–17, inclusive, were under the care of Messrs. Müller, Carmalt and McClure.

Dr. Freeborn described "Thoma's Frog-plates," employed on the occasion.

The thanks of the society were tendered Dr. Freeborn and Messrs. Müller, Carmalt and McClure for their assistance in the matter of these exhibits.

PUBLICATIONS RECEIVED.

The Microscope: Vol. IX., Nos. 10, 11 (October, November, 1889).

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The Microscopical Bulletin and Science News: Vol. VI., No. 5 (October, 1889).

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Meteoric Iron from Arkansas, 1886: By George F. Kunz.

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Precious Stones in Canada and British America. By George F. Kunz. 1888.

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Meteorites and what they teach us: By H. Hensoldt. 1889.

The Disposal of the Dead: By John M. Peacocke. 1889.

Wood's Lessons in Botany: A. S. Barnes & Co. 1889.

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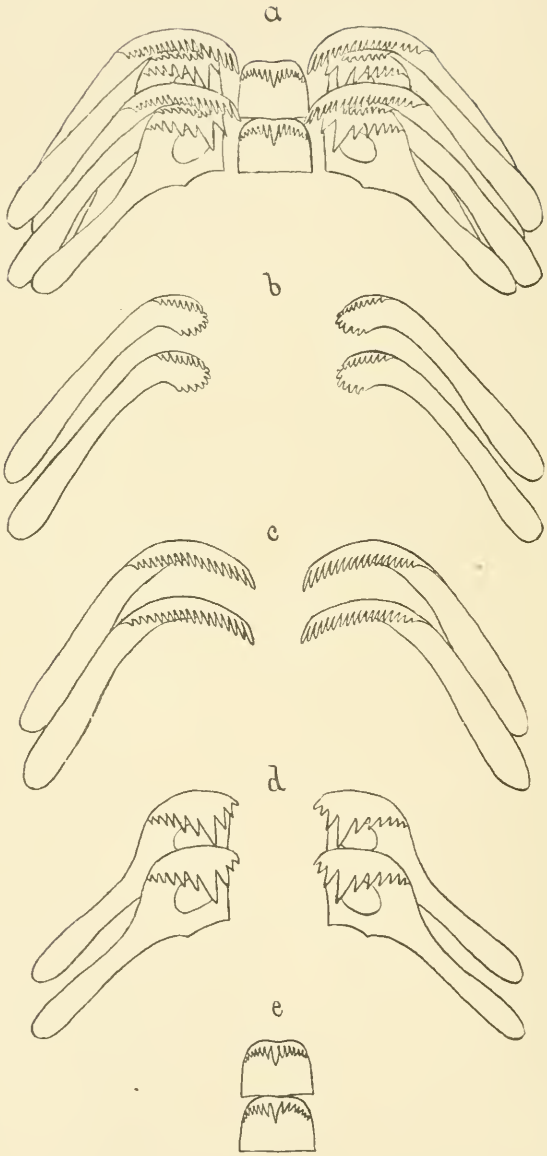

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PROTOPLASM AND THE CELL DOCTRINE.

ANNUAL ADDRESS OF THE PRESIDENT, CHARLES F. COX, M. A.

(*Delivered January 3d*, 1890.)

Truth, like the ocean, tends to a general level; but its surface is always ruffled by winds of speculation. All philosophy is either above or below the normal line of ascertained fact. A lack of knowledge keeps it in the trough of the sea; a superfluity of imagination carries it upward on the crest of the wave. In any case it holds a restless course, tossed hither and thither by the shifting breeze of opinion.

Every hypothesis starts from a point much lower than the actual truth-level, is pushed by the enthusiasm of its advocates far beyond the limit of rigid induction, and then, after many gradually weakening oscillations, is finally brought down to a state of nearly stable equilibrium by the force of logical gravitation.

Such has been, in part at least, the history of the hypothesis which has come to be known as the protoplasmic theory of life. The stream of doctrine which has resulted in this theory had its origin a little over fifty years ago, in a reaction from the then prevailing belief in a vital principle, or spiritual essence, which was not evolved by the parts or organs, but which entered into and took possession of the organism as a whole and caused it to live.

It would seem as if protoplasm must have come under the notice of the first serious worker with the microscope, although not

known by this name nor recognized for what it was afterwards seen to be. As early as 1755 Rosenhof described pretty clearly and correctly the curious phenomena of vitality as manifested in the movements of the "proteus animalcule" and seventeen years later Corti published his observations on the rotation in the cells of Chara. The similar process in Vallisneria was made known by Meyen in 1827, and in 1831 Robert Brown was overawing Charles Darwin with that "little secret," which proved to be his newly discovered cyclosis in the filaments of Tradescantia.

About the time that Corti was studying the formative material in Chara, Wolff, according to Professor Huxley, was trying to demonstrate, with reference to the higher animals, that "every organ is composed, at first, of a mass of clear, viscous, nutritive fluid, which possesses no organization of any kind, but is, at most, composed of globules."[1]

In 1835 Dujardin put forth his celebrated memoirs on the Foraminifera, in which he called attention to the "*substance animale primaire*," of which they are composed, which he described as "une sorte de mucus doué du mouvement spontané et de la contractilité," and to which he gave the name "*sarcode.*"

But according to Doctor Drysdale, Doctor Fletcher, of Edinburgh, is entitled to the credit of first having given the *coup de grâce* to "the old hypothesis of a vital spirit, or essence, or principle as the cause of life," and of having framed a new theory "of the anatomical nature of the living matter which anticipates, in a remarkable manner, the discovery of the protoplasmic theory of life." In support of this claim we are referred to Doctor Fletcher's "Rudiments of Physiology," published in 1835, in which it was argued (1.) "that there can be no central vital influence communicable to the parts and dominating them, for the vitality of each must be inherent in itself, and, as a property of the material compound, cannot be transferred to the smallest distance; each part, organ, and even cell, therefore, possesses a quasi-independent life, and they are all bound together to form an individual merely by the ties of a central nervous system and common circulation, or some similar

[1] "The Cell Theory." By Thomas H. Huxley. Brit. and For. Med. and Chir. Review, October, 1853.

means when these are not present;" and (2.) "that the property of vitality does not reside equally in the various organic structures requiring such different physical properties, but is restricted solely to a universally-diffused, pulpy, structureless matter, similar to that of the ganglionic nerves and to the gray matter of the cerebro-spinal nervous system."[2]

As Doctor Drysdale remarks, "the progress of physiological knowledge from the time of Fletcher may be said to be bound up in the history of the cellular theory, which may be considered practically to have begun in 1838." But, as stated by Doctor Tyson, "it is evident that for some time prior to the year 1838, the cell had come to be quite universally recognized as a constantly recurring element in vegetable and animal tissues, though as yet little importance had been attached to it as an element of organization, nor had its character been clearly determined."[3]

It is to be noted, however, that nearly all the earlier observers dealt exclusively either with animal or with vegetable cells. It is probable that Schwann was the first to bring both animal and vegetable worlds under a general theory of cell-formation and growth; although Oken, as far back as 1808, had declared that "animals and plants are throughout nothing else than manifoldly divided or repeating vesicles." Oken, however, appears to have been engaged wholly with the morphological resemblances between the elementary parts of animals and plants, and, as Schwann himself remarks, "nothing resulted from such comparisons, because they were mere similarities in figure between structures which present the greatest variety of forms."

In 1837 Schleiden had made his discoveries as to the process of origination and development in vegetable cells and had, previous to publication, laid his conclusions before Schwann. In enumerating the substances composing the cell-contents Schleiden referred to a semi-granular substance occurring in irregular forms, having no internal structure, which was colored brown by tincture of iodine, and which he proposed to call mucus. He however distinguished another, still simpler mat-

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[2] "The Protoplasmic Theory of Life." By John Drysdale, M. D., F. R. M. S. London, 1874.

[3] "The Cell Doctrine: Its History and Present State." By James Tyson, M. D. Philadelphia; 2d. Edn., 1878.

ter, apparently a portion of the former, and in this respect seems to have anticipated some of the very latest developments of the protoplasm theory, of which I shall speak by-and-by, though his distinction of parts in the mucus came to be entirely overlooked when the whole granular mass afterwards received the name of protoplasm. He taught that "the youngest structures are composed of another distinct, perfectly transparent substance, which presents an homogeneous, colourless mass when subjected to pressure;" which, after pressure, "appears as colourless as before, and is so completely transparent as to be altogether invisible when not surrounded by coloured or opaque bodies." This he named vegetable gelatine. "It is this gelatine," he says, "which is ultimately converted by new chemical changes into the actual cellular membrane, or structures which consist of it in a thickened state, and into the material of vegetable fibre."[4] Here we have at least the root of the doctrine of germinal matter and formed material.

Now, taking Schleiden's observations for his starting-point, Schwann made an immense advance upon them, by using them as a key to the mysteries of animal development, and by deducing from them a new and far-reaching generalization. The task he took upon himself was to prove that "one common principle of development forms the basis for every separate elementary particle of all organized bodies, just as all crystals, notwithstanding the diversity of their figures, are formed according to similar laws." He sums up the matter by saying that "in the fundamental phenomena attending the exertion of productive power in organic nature a structureless substance is present in the first instance, either around or in the interior of cells already existing, and cells are formed in it in accordance with certain laws, which cells become developed in various ways into the elementary parts of organisms."[5]

From this time on, for ten or twelve years, the history of the cell doctrine is little more than a record of shifting views as to the relative importance of the cell-wall and the cell-contents. In the contest, however, the enclosing membrane was constantly

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[4] "Contributions to Phytogenesis." By M. J. Schleiden. Sydenham Soc., 1847.

[5] "Microscopical Researches into the Accordance in the Structure and Growth of Animals and Plants." By Dr. Thomas Schwann. Translated by Hy. Smith. London, 1847.

losing and the enclosed plastic matter was constantly gaining in physiological significance. Even the nucleus was losing its essential character, so that when Cohn made known his observations on Protococcus Pluvialis,[6] the scientific world was ready to believe that the vegetative changes occurring in the cell-contents of this organism were brought about without the direct agency, if not actually in the absence, of any nucleus, whatever.

In 1844 Hugo von Mohl first applied the name protoplasm to the "opaque, viscid fluid of a white colour having granules intermingled in it," which he found filling the cells of plants.[7]

But now, in 1850, Cohn widened the boundaries of Schwann's great generalization by showing that there is not only a morphological similarity between the constituent cells of animals and those of plants but that there is a physiological analogy, if not also a chemical identity, between vegetable protoplasm and animal sarcode. He expressed the opinion that this common substance "must be regarded as the prime seat of almost all vital activity."

Up to this point the cell had been the only recognized vital unit, and the conception of an enclosing wall, semi-fluid contents, and a nucleus, as the essential and always present constituents, had been pretty generally insisted upon, although Cohn had partly disposed of the nucleus. *Omnis cellula e cellulâ* was still the orthodox tenet, when Leydig attempted to relegate the cell-wall to an incidental position as a mere hardened surface of the cell-substance, while retaining the nucleus as an indispensable centre of vitality, thus reducing the cell to "*protoplasm* inclosing a nucleus."[8]

In 1858 Professor Virchow abandoned the wall as an essential part of the cell, and gave in his adherence to the view that "a *nucleus* surrounded by a molecular blastema was sufficient to constitute a cell."[9]

But Doctor Tyson is disposed to award to Max Schultze "the credit of having fully overturned the vesicular idea of cells." Schultze, he says, in 1861, "insisted upon some modi-

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[6] Ray Society. 1853.

[7] "Principles of the Anatomy and Physiology of the Vegetable Cell." Translated by A. Henfrey. London, 1852.

[8] "Handbuch der Histologie." 1856.

[9] "Cellular Pathology." Translated by F. Chance. Philadelphia, 1863.

fication of prevailing views respecting the relation of cell-wall to cell-contents, and contended for a higher position for that part of the cell corresponding to the protoplasm of von Mohl, * * * * and showed how a careful study of the phenomena presented by the pseudopodia, extended by the various Rhizopods, might aid in clearing up the life of the elements of the cell. He also defined the cell as protoplasm surrounding a nucleus."[10]

Now the cell-wall ceases to occupy attention. Henceforth the contention is over the nucleus. Brücke attacked it in this same year and undertook to show that it has a very doubtful existence in the realm of cryptogamic botany, provided, as he naively remarks, we "do not start out with the belief that the nucleus is there even though we do not see it." The discovery of non-nucleated protozoa, soon after extended the same skepticism to the animal kingdom; and so the way was prepared for Beale's theory, which was then announced. Its basis was laid in some preliminary publications in 1860; but it was more formally expounded in 1861, in a series of lectures delivered at the Royal College of Physicians. Still later, it was further elaborated in ten lectures given at King's College.[11]

The substance of his theory, as set forth in these lectures, is that every living being, from the simplest to the highest and most complex, is composed partly of a semi-fluid, granular material and partly of more solid tissues; that the tissues are formed from the granular material; that the granular material is always within, the formed material on the outside of an elementary part; that the granular material alone is concerned in the operations of growth, nutrition, and development,—alone possess the power of selecting pabulum; that pabulum is worn-out tissue; and that therefore there are but two kinds of substances in every organism, namely, germinal matter and formed material:—the former always alive, the latter always dead.

He tells us that "the germinal matter which is formed in the nerves or muscles of any of the higher animals cannot be distinguished from the germinal matter in the tissues of the leaf of a plant, or from that which exists in the particles of the lowest

10 "The Cell Doctrine." P. 80.

11 "On the Structure and Growth of the Tissues, and on Life." London. 1865.

fungus," that germinal matter is met with in varying proportions in all living tissues, but that it is most abundant in those most actively growing, and that, in the earliest period of their existence, tissues are entirely composed of it. He claims to have shown "that every particle of matter exhibiting vital phenomena is derived, not from the formed material, but from pre-existing living or germinal matter, which exhibited similar phenomena, and so from the first creation." This living matter is always colourless, always contains much water, and is structureless and formless, although Doctor Beale says that it "consists of particles, which, when free, invariably become spherical," and that these spherules "are composed of spherules ad infinitum." Finally, he expresses the belief that, in the living state, "the elements of the matter and the forces associated with them are maintained in some remarkable and exceptional condition which is quite peculiar, to which no parallel whatever can be offered," and which he attributes "to the operation of *Vital Power.*"

Doctor Beale's King's College lectures were greatly expanded in later years, and underwent changes of form and of name; but I cannot see that much was really added to the substantial framework of his theory. A considerable weight of controversial matter, was, however, superimposed, and this proved, as might be expected, an element of weakness rather than of strength. But, although his later works did not actually enlarge the scope of his hypothesis, they afforded him opportunity to state more fully his views of some of the less essential details. Thus he was able to elaborate his conception of the wide separation between his two forms of organic substances, and to insist with more emphasis "that between the living state of matter and its non-living state there is an absolute and irreconcilable difference; that, so far from our being able to demonstrate that the non-living passes by gradations into, or gradually assumes the state or condition of the living, the transition is sudden and abrupt; and that matter already in the living state may pass into the non-living condition in the same sudden and complete manner; that while in all living things chemical and physical actions occur, there are other actions, as essential as they are peculiar to life, which, so far from being of this nature, are opposed to, and are capable of overcoming, physical and

chemical attractions;" and, moreover, "that the non-living matter is the seat of the physical and chemical phenomena occurring in living beings, but that the vital actions occur in the living matter only."[12]

But, beside furnishing the occasion for greater particularity in the exposition of his theory of life, Doctor Beale's newer presentation of the general subject opened the way to interesting and somewhat novel ideas concerning death. He accordingly undertook to convince us that "all form, colour, structure, mechanism, observed at a later period in the life-history of living things, result from changes in this primary structureless, colourless material, * * * * which looks like mere jelly, or a little clear gum or syrup;" and that these changes—these transitions from formative to formed—are universally accompanied by a cessation of life. They are the converse of the process by which dead pabulum becomes living protoplasm, and all vital action on one side and all organic form on the other result from the swing of the pendulum to and fro,—the down beat being no less important than the up beat. According to his conception "all bioplasm must die. By its death marvellous things are produced and wonderful acts are performed. Every form in nature,—leaves, flowers, trees, shells; every tissue,—hair, skin, bone, nerve, muscle,—results from the death of bioplasm. * * * * Once dead, bioplasm ceases to be bioplasm and is resolved into other things; but these things that are *formed* cannot be put together again to reform the bioplasm. They may be taken up by new bioplasm, and so converted into living matter; but the bioplasm that existed once can never exist again."

Concerning the origin of bioplasm, Doctor Beale offers no very distinctive belief. He says, however, that "whether one primitive mass of bioplasm was caused to be, in the first creation, or five, or fifty, or whether thousands or millions, rushed simultaneously or successively into being, is open to discussion; but the arguments in favour of the view that a minute mass of structureless bioplasm was the first form of living thing are so overwhelming that they must carry conviction."

A few years before these passages were written, Doctor Beale had first proposed, as an exclusive name for the "living or self-

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[12] "Bioplasm: an Introduction to the Study of Physiology and Medicine." London, 1872.

increasing matter of living beings," this word *bioplasm*, and in support of its application had urged that "now that the word biology has come into common use, it seems desirable to employ the same root in designating the matter which it is the main purpose of biology to investigate "[13] The word *protoplasm* had been associated with too many different substances to suit Doctor Beale's object which was to indicate matter in its most unstable form, before it has become an organ, a structure, a tissue, a cell;—while it is merely formative but still unformed. The older word, as Doctor Drysdale remarks, had "been used in a loose way and applied to objects which have no title to vitality," and, as the term *germinal matter* had, for some reason, been thought inconvenient, Doctor Beale sought to create a name which should mean simply and solely *living plastic matter*, or, as Huxley afterwards called it, *life-stuff*. But *protoplasm* could not be dispossessed and, though *bioplasm* is probably the better word, the older name descended by inheritance to the new idea, and even Beale himself accepted and used it in his later works.

In fact, there may be very good reason for this supremacy of the original designation if, as Doctor Drysdale asserts, "the living matter of Beale corresponds to the following histological elements of other authors: the viscid nitrogenous substance within the primordial utricle, called by von Mohl, protoplasm; the primordial utricle itself in Naegeli's sense of that term, viz., the layer of protoplasm next the cell-wall; the transparent, semifluid matter occupying the spaces and intervals between the threads and walls of those spaces formed by the so-called vacuolation of protoplasmic masses; the greater part of the sarcode of the monera, rhizopoda, and other low organisms; the white blood-corpuscles, pus-corpuscles, and other naked wandering masses of living matter; the so-called nucleus of the secreting cells, and of the tissues of the higher animals, and many plant-cells; the nuclei of the cells of the grey matter of the brain, spinal marrow, and ganglions, and the nuclei of nerve-fibres."

Doctor Beale himself puts the case quite as strongly in his latest work on this general topic, in which he says: "if certain authorities were asked to define exactly the characters of the matter which they called protoplasm, we should have from those

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[13] Quart. Jour. Mic. Sci. July, 1870.

authors definitions applying to things essentially different from one another. Hard and soft, solid and liquid, coloured and colourless, opaque and transparent, granular and destitute of granules, structureless and having structure, moving and incapable of movement, active and passive, contractile and non-contractile, growing and incapable of growth, changing and incapable of change, animate and inanimate, alive and dead,—are some of the opposite qualities possessed by different kinds of matter which have nevertheless been called protoplasm."[14]

Notwithstanding the justness of this criticism of the general looseness of other authors, there is some ground for thinking that Doctor Beale has not been entirely clear and consistent in his description and identification of his own germinal matter; for, although he declares that "bioplasm or living matter is always transparent, colourless, and, as far as can be ascertained by examination with the highest powers, *perfectly structureless*," he afterwards speaks of the substance of the amoeba as being "darker and more granular in some places than in others;" he distinctly admits that "the bioplasm of all organisms, and of the tissues and organs of each organism, exhibits precisely the same characters;" and he still later refers to the "component particles" of bioplasm, which he finally distinguishes as bioplasts. The ovum, he tells us, "at an early period of its development is but a naked mass of bioplasm, without any cell-walls, but having a new centre or many new centres (known as germinal spots or nuclei) embedded in it." These germinal spots "are in fact new living centres of growth," and we may perhaps be excused for asking whether the existence of so great differences of function in different parts of the bioplasm of the amoeba, the white blood-corpuscle, the Vallisneria bioplasm, the mucus corpuscle, and the ovum, are not pretty strong indications of structure. The question is therefore whether these things are, after all, composed entirely of bioplasm; for Doctor Drysdale lays down the rule that "the name of bioplasm, given by Beale, or protoplasm (in a restricted sense, as it will probably be ultimately accepted by biologists), as indicating the *ideal* living matter, cannot be given to any substance displaying rigidity in any degree, from the softest gelatinous membrane up

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[14] "Protoplasm: or Matter and Life." 1874.

to the hardest teeth-enamel ; nor to anything exhibiting a trace of structure to the finest microscope ; nor to any liquid ; nor to any substance capable of true solution."[15]

It is plain from all that has been said that Beale's theory dispenses with the cell-wall as an essential part of the ultimate physiological unit, and that under his system the nucleus becomes a mere centre of activity :—the spot where vitality bubbles up and overflows to the adjacent protoplasm. The mystery of life is therefore narrowed to a veritable point within a simple habitat ; and, in the words of Doctor Drysdale, the problem which Doctor Beale had undertaken was "to account for all the vital phenomena of a complicated individual of the higher orders by the sole action of this structureless, clear, semi-fluid matter."

But now Professor Huxley takes in hand the broader task which Cohn had begun twenty years earlier, in an endeavor to prove that "there is some one kind of matter which is common to all living beings, and that their endless diversities are bound together by a physical, as well as an ideal, unity." This is the primary thesis of his lecture on "The Physical Basis of Life,"[16] or, as he at first entitled it, "The Bases of Physical Life."[17]

Now Doctor Beale has said that, although all bioplasm possesses certain common characters, "we must admit that in nature there are different kinds of bioplasm indistinguishable by physics and chemistry, but endowed with different powers, flourishing under different circumstances, consuming different kinds of pabulum, growing at a different rate and under very different conditions as regards temperature, moisture, light, and atmosphere, posessing different degrees of resisting power, and dying under very different circumstances, having varying powers of resisting alterations in external conditions." Doctor Beale's bioplasm is therefore an "ideal" living matter, of a generic similarity rather than of a specific identity.

Although the general purpose of Professor Huxley's essay is to show that all protoplasms are one, or that they are mutually convertible into one another, he is obliged, at the outset, to

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15 "The Protoplasmic Theory of Life." P. 45.

16 Fortnightly Review. Feby. 1, 1869.

17 The Scotsman. Nov. 9, 1868.

make an admission somewhat in the line of Doctor Beale's distinction between bioplasms "consuming different kinds of pabulum;" for he is so frank as to say that "notwithstanding all the fundamental resemblances which exist between the powers of the protoplasm in plants and in animals, they present a striking difference * * * * in the fact that plants can manufacture fresh protoplasm out of mineral compounds, whereas animals are obliged to procure it ready made, and hence, in the long run, depend upon plants." While his imaginative eye is able to see a "community of faculty * * * * between the brightly-coloured lichen, which so nearly resembles a mere mineral incrustation of the bare rock on which it grows, and the painter to whom it is instinct with beauty, or the botanist, whom it feeds with knowledge," or to discern a hidden bond connecting "the flower which a girl wears in her hair, and the blood which courses through her youthful veins;" he nevertheless stops to have it "understood that this general uniformity by no means excludes any amount of special modifications of the fundamental substance." Still, in the protoplasm of the microscopic alga or fungus, and that of the leaf-cell or leaf-hair; in the substance of the organless and almost formless moner or amoeba, and that of the ever-changing white blood-corpuscle of a whale or of a man; in the matter of the nucleated epithelial cell, and that of the animal ovum; he beholds "the clay of the potter; which, bake it and paint it as you will, remains clay, separated by artifice and not by nature, from the commonest brick or sun-dried clod." "Thus," he concludes, "it becomes clear that all living powers are cognate, and that all living forms are fundamentally of one character."

Then he goes on to say, "the researches of the chemist have revealed a no less striking uniformity of material composition in living matter. In perfect strictness it is true that chemical investigation can tell us little or nothing, directly, of the composition of living matter, inasmuch as such matter must needs die in the act of analysis." One fact, however, remains out of reach of the refinements of logic which objectors have raised upon this point: "and this is that all the forms of protoplasm which have yet been examined contain the four elements, carbon, hydrogen, oxygen, and nitrogen, in very complex union and that they behave similarly towards several reagents."

As to the bearing of all this upon the cell-doctrine, Professor Huxley gives it as his opinion that "a nucleated mass of protoplasm turns out to be what may be termed the structural unit of the human body. As a matter of fact, the body in its earliest state, is a mere multiple of such units; and, in its perfect condition, it is a multiple of such units variously modified." "But," asks Professor Huxley, "does the formula which expresses the essential structural character of the highest animal cover all the rest, as the statement of its powers and faculties covered that of all others?" And his reply is: "Very nearly. Beast and fowl, reptile and fish, mollusk, worm, and polype, are all composed of structural units of the same character, namely masses of protoplasm with a nucleus. There are sundry very low animals, each of which, structurally, is a mere colourless blood-corpuscle leading an independent life. But at the very bottom of the animal scale even this simplicity becomes simplified, and all the phenomena of life are manifested by a particle of protoplasm without a nucleus."

It ought, however, to be pointed out here, as it was long ago by certain writers, that, notwithstanding the similarity in form between a moner and a white blood corpuscle, the corpuscles of a whale spilled in the sea would not continue their existence as monera, nor would monera injected into the veins of one of the higher animals perform the offices of the blood-corpuscles.

At any rate, it is very evident that Professor Huxley is one of those who have discarded the cell-wall as an essential part of the structural unit, though it is not quite certain that he is ready wholly to relinquish the nucleus. Still, his theory, like Beale's, calls for a formative *matter*, rather than a forming *vesicle*, as the foundation of every living structure, and the cell-wall, when there is any, becomes a result of what then becomes cell-contents:—the latter being cause to the former as effect, just as the test is the product of the enclosed foraminifer, or the shell of the mollusk.

Having settled upon a mere mass of living matter as the structural unit, Professor Huxley inquires "now what is the ultimate fate and what the origin of the matter of life? Is it, as some of the older naturalists supposed, diffused throughout the universe in molecules which are indestructible, and unchangeable in themselves; but, in endless transmigration, unite in

innumerable permutations, into the diversified forms of life we know? Or is the matter of life composed of ordinary matter, differing from it only in the manner in which its atoms are aggregated? Is it built up of ordinary matter, and again resolved into ordinary matter when its work is done?" To these queries Professor Huxley, in the name of modern science, answers, as Doctor Beale would answer, that "under whatever disguise it takes refuge, whether fungus or oak, worm or man, the living protoplasm not only ultimately dies and is resolved into its mineral and lifeless constituents, but is always dying, and, strange as the paradox may sound, could not live unless it died." "All work," he goes on to say, "implies waste, and the work of life results, directly or indirectly, in the waste of protoplasm." But "it is clear that this process of expenditure cannot go on forever," and so the problem is reached: how is the renewal of protoplasm accomplished? Here again Professor Huxley answers as Doctor Beale would answer:—by the appropriation and assimilation of pabulum; but as to the nature and properties of pabulum, he and Doctor Beale differ absolutely.

To Doctor Beale there is as much difference between living protoplasm and dead pabulum as there is between the ox and his hay. To him living protoplasm alone is protoplasm. No such thing as dead protoplasm is possible. Protoplasm invariably dies into formed material, and formed material may become pabulum. Pabulum does, indeed, again become protoplasm; but the three things I have named are always perfectly distinct, at least there is an absolute gulf between protoplasm and pabulum; and when pabulum becomes protoplasm it is by a sudden, less than instantaneous, leap, and not by a graded progression.

But to Professor Huxley, the mutton, lobster, or bread which he supposes himself to take for the replenishment of his wasted protoplasm, appears to be itself protoplasm, though he speaks of it as dead for the time being, and as if its life-history (whether in biped, quadruped, crustacean, or cereal) depended merely upon the channel into which it chanced to drift, and the motion it happened to acquire, as it was borne along the general stream of organic existence; for he says: "this mutton was once the living protoplasm, more or less modified, of another animal,—a sheep. As I shall eat it, it is the same matter altered, not only by death, but by exposure to sundry artificial operations in the

process of cooking. But these changes, whatever be their extent, have not rendered it incompetent to resume its old functions as matter of life. A singular inward laboratory, which I possess, will dissolve a certain portion of the modified protoplasm, the solution so formed will pass into my veins; and the subtle influences to which it will then be subjected will convert the *dead protoplasm* into *living protoplasm* and transubstantiate sheep into man. Nor is this all. If digestion were a thing to be trifled with, I might sup upon lobster, and the matter of life of the crustacean would undergo the same wonderful metamorphosis into humanity. And were I to return to my own place by sea, and undergo shipwreck, the crustacea might, and probably would, return the compliment, and demonstrate our common nature, by turning my protoplasm into living lobster. Or, if nothing better were to be had, I might supply my wants with mere bread, and I should find the protoplasm of the wheat-plant to be convertible into man, with no more trouble than that of the sheep, and with far less, I fancy, than that of the lobster. Hence it appears to be a matter of no great moment what animal, or what plant, I lay under contribution for protoplasm, and the fact speaks volumes for the general identity of that substance in all living beings. I share this catholicity of assimilation with other animals, all of which, so far as we know, could thrive equally well on the protoplasm of any of their fellows, or of any plant."

This argument was taken up and commented upon somewhat satirically and, as I think, in the main, reasonably, by Doctor Sterling, who has said, with reference to it, "Is it true that every organism can digest every other organism, and that thus a relation of identity is established between that which digests and whatever is digested? * * * * It is very evident that there is an end of the argument if all foods and all feeders are essentially identical both with themselves and with each other. * * * * It is not long since Mr. Huxley himself pointed out the great difference between the foods of plants and the foods of animals. * * * * Mr. Huxley talks feelingly of the possibility of himself feeding the lobster quite as much as of the lobster feeding him; but such pathos is not always applicable; it is not likely that a sponge would be to the stomach of Mr. Huxley any more than Mr. Huxley to the stomach of a sponge.

* * * * We can neither acquire the functions of what we eat, nor impart our functions to what eats us. We shall not come to fly by feeding on vultures, nor they to speak by feeding on us. No possible manure of human brains will enable a corn-field to reason." [18]

On the subject of chemical constitution Professor Huxley says "it will be observed that the existence of the matter of life depends on the pre-existence of certain compounds, namely, carbonic acid, water and ammonia. Withdraw any one of these three from the world and all vital phenomena come to an end. They are related to the protoplasm of the plant, as the protoplasm of the plant is to that of the animal. Carbon, hydrogen, oxygen, and nitrogen are all lifeless bodies. Of these carbon and oxygen unite in certain proportions and under certain conditions, to give rise to carbonic acid; hydrogen and oxygen produce water; nitrogen and hydrogen give rise to ammonia. These new compounds, like the elementary bodies of which they are composed, are lifeless. But when they are brought together under certain conditions they give rise to the still more complex body, protoplasm, and this protoplasm exhibits the phenomena of life. I see no break in this series of steps in molecular complication, and I am unable to understand why the language which is applicable to any one term of the series may not be used to any of the others;" and so he at last comes to ask: "What better philosophical status has *vitality* than *aquosity?*" To which Doctor Sterling replies: "The molecules are as fully accounted for in protoplasm as in water; but the sum of qualities thus exhausted in the latter, is not so exhausted in the former, in which there are qualities due, plainly, not to the molecules as molecules, but to the form into which they are thrown, and the force that makes that form one. * * * * As the differences of ice and steam from water lay not in the hydrogen and oxygen, but in the heat, so the difference of living from dead protoplasm lies not in the carbon, the hydrogen, the oxygen, and the nitrogen, but in the vital organization. In all cases, for the new quality, plainly, we must have a new explanation. The qualities of a steam-engine are not the results of its simple chemistry."

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[18] "As Regards Protoplasm." By James Hutchison Sterling, LL. D. Edinburgh, Oct. 1869, 2d edn., 1872.

Whatever we may think of this discussion, we must perceive that, by this time, the cell doctrine had been wholly lost sight of, and that the protoplasm theory had occupied the entire field, although Doctor Beale was still feebly expressing the hope "that the short convenient word *cell* should not be discarded," and was venturing to "think that the phenomena essential to living matter are only possible in minute masses separated from one another, so that each may be supplied upon its circumference with nutrient materials." But it had become a general tendency to make life an attribute of a *substance* as distinguished from a *form*. As Doctor Sterling said with reference to Professor Huxley, the thing aimed at, as a result of mere ordinary chemical process, was "a life-stuff in mass, as it were in the web, to which he has only to resort for cuttings and cuttings in order to produce, by aggregation, what organized individual he pleases;" or, as he describes it more briefly, protoplasm by the spoonful or toothpickful.

Now this basal matter of life, which was thus to be taken by the spoonful or toothpickful to make a living organism, was at this time, by common consent, looked upon as a homogeneous, structureless substance, not distinguishable in merely physical constitution from other members of the class proteids;—a veritable colloid, differing from other colloids only in the respect of being as ceaselessly active as they are continually passive. Very soon, however, even this doctrine of homogeneousness and structurelessness was attacked; for, as it would seem we might have anticipated, increasing microscopical powers and improving methods of observation began to disclose to some investigators first differences of function in different portions of the heretofore seemingly undifferentiated protoplasm of the lower organisms, and then an actual structure which narrowed the basis of life to a fine net-work within what before had been regarded as a wholly living substance.

This condition of things had not been suspected by Professor Huxley and others who believed that protoplasm as they saw it in the nettle-sting and in the white blood-corpuscle was absolutely the starting-point of structural evolution;—a simple formative, but formless, matter. They were compelled, however, to recognize the fact that one bit of apparently homogeneous living jelly was bound to follow a life-history entirely dis-

tinct from that of another bit of living jelly optically exactly like it ; and that the one never would fulfill by accident, and never could be made to fulfill, the destiny of the other. But this difference of function and behavior in forms merely looking alike, they undertook to account for either by purely chemical symbolism, as we have seen Professor Huxley doing, or else by arguments from the laws of molecular physics. Thus Professor Rutherford, at the British Association meeting in 1873, said : "There appears to be no reason for supposing that two particles of protoplasm, which possess a similar microscopic structure, must act in the same way ; for the physicist knows that molecular structure and action are beyond the ken of the microscopist, and that within apparently homogeneous jelly-like particles of protoplasm there may be differences of molecular constitution and arrangement which determine widely different properties." Hæckel also had said : "All the immeasurable variety in the most diverse properties of organic bodies perceptible to the senses, which excite and delight our perceptions, is to be traced back to the alike infinitely numerous and delicate differences in the atomic constitution of the albumen-compounds which constitute the plasma of the plastids."[19]

The trouble with these arguments is that they assume that investigation into the composition of protoplasm had really got down as deep as molecular structure. The fact is that the occasion had not yet arisen for a final refuge in what Professor Tyndall has aptly termed "the scientific use of the imagination ;" for it was soon proven that the resources of instrumentally-aided eye-sight had been by no means exhausted. Purely optical methods began to develop a necessity for a distinction of parts in what had been regarded as homogeneous, and the introduction of the words "cytoplasma," "hyaloplasma," "polioplasma," "paraplasma," etc., into the nomenclature of the subject, testified to the differentiation which was coming to light.

Professor Goodale has set forth very clearly the changes which have taken place in the botanical phase of this subject during the last twenty years, in his presidential address to the biological section of the American Association, at its recent Toronto meeting. He shows that at the beginning of this period "the following points were regarded as established : 1. All of

[19] "Generale Morphologie."

the activities of the vegetable cell are manifested in its protoplasmic contents ; 2. Protoplasm consists chemically of a nitrogenous basis ; 3. Protoplasm has no demonstrable structure ; 4. The protoplasmic contents in one vegetable cell are not connected with the protoplasmic contents in adjoining cells ; 5. The nucleus and other vitalized granules in the vegetable cell are formed by differentiation from amorphous protoplasm ;" and that, while the first proposition may be considered as finally established, the conception of the second has been considerably modified, and all the others have been completely disproved. He says, further, that "instead of regarding the protoplasmic basis as comparatively simple, it is now known to be exceedingly complex, and to contain numerous cognate proteids, some of which can be identified in the basic mass, others in the nucleus, and others still in the vitalized granules ;" and that the results of various studies "compel us to recognize in protoplasm a substance of bewildering complexity of composition and constitution."

This fact began to be apparent in the animal realm when Heitzmann, Klein and others announced the discovery of an "intra-cellular net-work" in the white blood-corpuscle, the points of intersection of the reticulum being what had been previously called the granules. In a paper read before our New York Academy of Sciences in 1879,[20] Doctor Elsberg called attention to the communication to the Vienna Academy, in 1873, in which Doctor Heitzmann "demonstrated the existence of a net-work in amœbæ, blood-corpuscles of astacus and of triton, human colorless blood-corpuscles and colostrum corpuscles ; and, from direct observation of the changes in the reticulum during the contraction of the living body, announced that the substance constituting the net-work is itself the living matter or bioplasm ;" and Doctor Elsberg himself endeavored to demonstrate a similar structure in the red blood-corpuscles.

I can well remember, as perhaps you also can, the disgusted incredulity with which this new doctrine was received,—an incredulity in which, I confess, I then shared I am not sure that the appearance of a reticulum in the prepared blood-corpuscle is even yet generally accepted as evidence of a normal structure of the kind claimed by Doctor Heitzmann ; but the claim cer-

[20] "The Structure of Colored Blood-Corpuscles." Annals N. Y. Acad. Sci. Vol. I.

tainly gains support from the fact that vegetable histologists are pretty well agreed that a more or less similar reticulum is demonstrable in the protoplasm of plants. Professor Goodale seems to have no doubt on this point, although he thinks that "this conception of protoplasm as a mass composed of a net-work of minutest fibres enclosing in the meshes another substance, presents * * * * great difficulties when we endeavor to explain the movements within the cell;" and that "it is very difficult to explain in any way the so-called wandering of protoplasm outside the cell-wall or into intercellular spaces."

Doctor Heitzmann, however, considers the reticulum or mesh an easy explanation of protoplasmic movements. To him the net-work of living, contractile matter contains in its interstices a lifeless liquid, which, by its contraction, it is able to squeeze out of itself, or from one part to another. Thus, he says, "the liquid held in the meshes, being driven out of the contracted portion will rush into a portion at the time at rest, and will extend this portion in the shape of what has been termed pseudopodia."[21]

In the work from which I have just quoted, Doctor Heitzmann generalizes as follows: "What * * * * was called a structureless, elementary organism, a 'cell,' I have demonstrated to consist only in part of living matter, while even the minutest granules of this matter are endowed with manifestations of life. The cell of the authors, therefore, is not an elementary, but a rather complicated, organism, of which small detached portions will exhibit amœboid motions. * * * * How complicated the structure of a minute particle of living matter may be, we can hardly imagine; what we do know is that the so-called 'cell' is composed of innumerable particles of living matter, every one of which is endowed with properties formerly attributed to the cell-organism."

It having been shown that life hangs upon a web of infinite tenuity, and does not reside necessarily in either a vesicle or a lump, it was a natural and easy step to extend this net-work from tissue to tissue and organ to organ, in an unbroken circuit of vital communication. This step Doctor Heitzmann does not hesitate to take; for, says he, "there is no such thing as an isolated, individual cell in the tissues, as all cells prove to be joined

21 "Microscopical Morphology." New York, 1883.

throughout the organism, thus rendering the body *in toto* an individual. What was formerly thought to be a cell is, in the present view, a node of a reticulum traversing the tissue. * * * * The living matter of the tissues exists mainly in the reticular stage, and is interconnected without interruption throughout the body."

Again this at first very strange and, for some reason or another, unwelcome doctrine receives support from the investigations of botanists; for, as Professor Goodale remarks, this protoplasmic intercommunication between adjoining cells "has been shown to be so widely true in the case of the plants hitherto investigated, that the generalization has been ventured on that all the protoplasm throughout the plant is continuous." The position to which we have traced this matter is, then, that to the latest biology, in any particular organism, a generally diffused and interconnected substance, simple only in appearance under present optical aids, has taken the place of the circumscribed, more or less isolated and independent, and recognizably complex vesicle which was the physical basis of life to the science of fifty years ago. In the words of Doctor Heitzmann, "according to the former view, the body is composed of colonies of amœbæ: according to the latter, the body is composed of one complex amœba."

Here we must pause to note briefly what effect this abolition of the cell-doctrine has had upon the conception of vitality. I said at the beginning of my address that the protoplasmic theory of life might be traced up-stream to a revolt against the belief in a vital principle received into the organism as a whole,—not evolved by its organs or parts. In other words, the newer tendency was supposed to be distinctly materialistic, as against the older faith which was plainly spiritualistic. According to the earlier conception, every man was a doubly-refracted image,—a bodily person overlying a spiritual person,—the one co-extensive with the other. Substantially the same idea was extended to the lower animals and to plants; whatever the vitalizing essence was, it was a whole, as the animal or the plant was a whole. The manifestation of life in an organism was not looked upon as an aggregate of the vital actions of minor parts, emanating and radiating from them, but as a pervading principle received into the parts, through the whole from without, as a

sponge absorbs water and sucks it into every cavity. Life, in short, was regarded as centripetal, not centrifugal ; and there was thought to be Scripture warrant for this view, in the record of the fact that the Creator, after fashioning the human form from purely inert material, at last breathed into it the breath of life and raised it up a sentient being.

But the tendency of the cell-doctrine was to disintegrate the vital principle,—to drive it into minute and independent centres,—to destroy the long-accepted idea of individuality. In place of one body containing one living spirit, a new conception was introduced, as we have seen, of an infinitely multiple body composed of absolute, though very minute, units, each possessing in itself all the essentials to vitality,—each inhabited by its own little vital spirit.

Now, when Beale announced his discovery of the seat of all vital action in a mere life-manifesting substance, without cell-wall or nucleus, and even, as he imagined, without structure, which substance was contained within every living tissue throughout the organism, he was supposed to have aimed a fatal blow at the materialistic conception of life. But we have observed how Professor Huxley, starting with Beale's ideal living matter, turned the argument again into the materialistic channel and undertook to prove, from Beale's premises, a conclusion in favor of mere chemistry and physics as against Beale's provisional "vital power." We have seen, too, how he shaped his argument to the thesis "all flesh is grass," or, as perhaps he would prefer to say, all flesh is clay, and the whole world is one great laboratory, and its sole shaping and directing powers are the physical and chemical forces ;—men are not different from other animals except in position ; all are but machines and their actions are automatic, originating in the functions not of separate cells, to be sure, but of separate masses, manifesting, in different ways, after all, only modes of one motion, namely, contractility.

Then came the men who dissected and analyzed Huxley's physical basis of life and showed that its bulk and substance is in truth as lifeless as the water in the sponge ; who replaced his life in masses or lumps by what Doctor Sterling had already unwittingly designated as "life in the web." And so we have arrived at a point in our historical survey at which life is supposed literally to hang upon a slender thread, intact throughout,

though infinitely extended and interwoven through the whole organism. Upon this warp the ancient figure of a vital spirit may easily be rewrought ; once more the way is prepared for a re-entrance of the spiritualistic conception of life. The breath of speculation has thus blown upon the surface of truth, and we have seen wave after wave roll by, each in its turn filling the field of vision and obscuring the level horizon beyond. But one wave cannot be more permanent than another, and the last we have looked upon is not in fact the last.

While the protoplasm theory has been assuming the form just mentioned, the cell doctrine also has been taking on an entirely new aspect. The door has suddenly been opened to a whole world of hitherto unknown non-nucleated organisms whose study is now engrossing the attention and monopolizing the energies of investigators everywhere. Bacteriology is the key to present biology. Strangely enough, too, we are once more eagerly searching for a solution of the problem of life through a close scrutiny of the phenomena of death ; for these new organisms, which are found to swarm in unimaginable plenitude, seem to be the counterbalance on the forces of vitality. "Mildew, mould, bacteria, * * * * monads, two thousand of which would go to make up a millimeter, all these microscopic organisms are charged with the great work of re-establishing the equilibrium of life by giving back to it all that it has formed." [22]

To Louis Pasteur belongs the credit for a large part of the labor of investigating the offices and actions of these micro-organisms, or microbes, in the processes of disorganization and dissolution. To him belongs the whole of the credit for reducing these processes to a single genus or type. He first explained to us the *modus operandi* of the formerly mysterious operations of death, decay and putrefaction, with their accompanying and complementary phenomena of resuscitation, nutrition, and reproduction. As M. Radot says, in summing up Professor Pasteur's conclusions on this subject, "All that has lived must die, and all that is dead must be disintegrated, dissolved or gasified ; the elements which are the substratum of life must enter into new cycles of life. If things were otherwise the matter of organized beings would encumber the surface of the earth, and the law of

[22] "Louis Pasteur, His Life and Labors." By his Son-in-law (M. Radot).

the perpetuity of life would be compromised by the gradual exhaustion of its materials. One grand phenomenon presides over this vast work, the phenomenon of fermentation." It was Pasteur who first clearly demonstrated that fermentation is always dependent on the life of a microscopic organism : that in fact it is "simply a phenomenon of nutrition." As Professor Tyndall says, in his introduction to the work from which I have just quoted : "with true scientific instinct, he closed with the conception that ferments are, in all cases, living things, and that the substances formerly regarded as ferments are, in reality, the food of the ferments ;" or, in the words of M. Radot, "the organism eats one part of the fermentable matter." Here, then, we have two of Beale's physiological elements, a speck of bioplasm and pabulum, translated into a uni-cellular ferment and its fermentable habitat.

Now, side by side with the new philosophy of fermentation there has developed a revolutionary idea in pathology, which has come to be known as the germ theory of disease. At first this theory was, as usual, pushed to an untenable extreme, in an assertion that all diseases were immediately caused by microbes which were introduced into the system from without and which produced their effects by a direct attack upon the tissues in which they lodged. As a result of the new philosophy of fermentation, however, it was soon found that microbes, acting as ferments, produced, by their action upon fermentable substances, peculiar chemical compounds, resembling the vegetable alkaloids, and which are now called ptomaines. This discovery led to a pretty lively discussion as to whether the microbe or the ptomaine was the immediate cause of the disease which ensued upon the introduction of a microbe into a living body ; and not until a ptomaine had been separated from its associate microbe and, by inoculation, had been caused to produce the disease previously supposed to be dependent on the presence of the microbe itself, was it admitted that, in some cases at least, the microbe was only an indirect cause of the disease, and the ptomaine was the more immediate.

It then became apparent that there were still two quite distinct classes of diseases, the infectious, originating without, and the autogenous, originating within, the organism. Plainly the latter did not easily come under the germ theory. It was next dis-

covered that even in the healthy animal system alkaloids were being constantly compounded, which could not be clearly distinguished from the vegetable alkaloids, or ptomaines. For these the name leucomaines was invented. But, having found that ptomaines were always products of fermentation, it was a natural step to the assumption that leucomaines must be results of a like process ; and good reasons quickly appeared for this generalization. Fermentation, during which ptomaines are produced, being a phenomenon of nutrition, as between a unicellular organism and its pabulum : the organism, the ferment, being introduced from without into the fermentable substance ;—analogy easily led to the conclusion that the production of leucomaines is a phenomenon of nutrition as between the normal constituent element of the body—(whether the old-fashioned cell, or the new-fashioned protoplasmic reticulum),—and its nourishing fluid.

Professor Joseph LeConte has recently called attention to this latest tendency of the cell doctrine, on which subject he says : " We have seen that ptomaines are alkaloids of albuminoid decomposition generated in the presence and under the guidance of microbian life. Now there is going on continually in the animal body, as a strictly physiological process, albuminoid decomposition (wasting of the tissues) in the presence and under the guidance of cell life. This also, as might be expected, produces poisonous products * * * * If they are not also usually deadly to the animal body, it is only because they are continually being eliminated by appropriate organs."[23] And this elimination, we may well imagine, is a result of the operation of natural selection, which has not yet produced immunity against all ptomaines, as it has against most leucomaines.

As it is not my purpose to discuss the germ theory itself, I shall not follow this subject further. Sufficient has been said to indicate the direction in which the cell doctrine, or perhaps I should say the protoplasm theory, is once more moving.

I must therefore bring my already too lengthy sketch to an end although, before actually closing, I cannot refrain from summarizing some of the conclusions which seem to me to be justified by the historical survey which I have endeavored to make.

First, then, the original idea of the cell, as propounded by

[23] Letter to "Science," Nov. 8, 1889.

Schleiden and Schwann, has gradually faded away. Such cells as they actually saw, do, indeed, still exist; but the cells they thought they saw have been deprived of all that were by them considered essentials. The attention of the defenders of the cell doctrine has been forced from cell-wall to nucleus, from nucleus to nucleolus, from nucleolus to plastids, from plastids to germinal points; a mathematical reduction to mere position without dimension;—a subjective conception, not an objective realization. Parenchyma cells in plants, and epithelial cells in animals, are no less constituent rooms in an organic building than they formerly were; but to the later science they are not the fundamental, autonomous units they were to the earlier science. Fifty years ago such cells as these stood upon the horizon of biological insight. To-day our vision extends far beyond them. To-morrow it will doubtless reach to distant points now even unimagined. At any rate, it is safe to say that, in the present condition of science, we have no actual knowledge of an ultimate unit, either physical or physiological. Science, nevertheless, like the youth in search of the gold at the end of the rain-bow, is ever pressing forward to fancied finalities, only to find new starting-points for a continuation of the race.

Second, no one has ever really seen Doctor Beale's ideal living matter. What he saw and called bioplasm was simple enough, compared with Dujardin's sarcode; but, like sarcode, his bioplasm has proved to be exceedingly complex. At this moment the idea embraced in his designation, *germinal matter*, is applicable, if to any actually visible thing, to a mere skeleton of his original bioplasm. Next year it may be applicable to only a small part of this attenuated reticulum;—and so on *ad infinitum.*

Third, Huxley's physical basis of life is pushed ahead again into the realm of the imagination. There probably is a physical basis, but it is not the particular basis Professor Huxley had in view; because the protoplasm of the nettle-sting, the protoplasm of the globergerina, and the protoplasm of the blood-corpuscle are clearly proven to be different protoplasms, chemically as well as physically and physiologically. Moreover, it is pretty certain that one protoplasm cannot be converted into another, except through the process of dying, becoming pabulum, being decomposed by fermentation, converted into new compounds and appropriated and assimilated;—which is a somewhat compli-

cated and, withal, mysterious operation. Professor Huxley's easy transubstantiation of protoplasm known as boiled mutton into protoplasm known as human brain-tissue, is consequently a myth.

This leads me to say, *Fourth*, that there appears to be no one visible and tangible substance to which the name protoplasm is rigidly and exclusively applied. As soon as we withdraw it from a purely philosophical concept, we find it attached to almost every sort of crude material which can by any possibility enter into the composition of a living structure. The name is, in particular, applied to any and every substance of a proteinaceous nature. In fact, with some writers, protoplasm is pretty nearly synonymous with proteid. Botanists are specially inexact in this respect. Having appropriated the name albumen for a substance not at all albuminous, they now seem to have adopted protoplasm as a designation for materials anything but protoplasmic. Beale's protoplasm, you will remember, is homogeneous, and structureless, and always contains much water. Professor Geddes, however, speaks of the "comparatively solid, almost brittle, state of the quiescent protoplasm of some seeds;"[24] and Professor Goodale tells us that the protoplasm of many kinds of seeds and spores can preserve its vitality during exposure to dry air at a temperature above that of boiling water under which condition he admits that it would be thoroughly dessicated.[25] "The consistence of protoplasm," he says, "depends on the amount of water which it contains. Thus in dry seeds it is nearly as tough as horn, while in the same seeds during germination it becomes like softened gelatin."[26] In another place he speaks of "inactive, amorphous protoplasm, as it sometimes exists in certain cells, where it is simply a tough, shapeless mass."[27] Fancy Doctor Beale's germinal matter reduced to the consistency of horn, or even to that of softened gelatin!

But, *Fifth*, if in some seeds (the so-called vegetable ivory, for example,) the only vitalizable substance is a solid, brittle, tough and horny proteid, it looks as if we had struck an inexplicable puzzle in the sudden appearance of the semi-fluid plastic proto-

[24] Encyclopædia Britannica; article, Protoplasm.

[25] Gray's Physiological Botany, p. 205.

[26] Ibid, p. 28.

[27] Ibid, p. 44.

plasm when the embryo begins to grow. Doctor Sterling, as well as Doctor Beale, insisted that vitality was an inherent and inseparable attribute of real protoplasm, and that consequently there could not be such a thing as dead protoplasm. I doubt whether, under their definitions, there can be even a dormant protoplasm ; for, in truth, what is dormant life, which this implies? Is it not in effect dead life? That is to say, is it not the essential sign of life that it is not dormant? Beale urges that there is no intermediate step between dead matter and living matter. Matter, he argues, is either wholly alive or wholly dead. Latent life, then, is at bottom only one of the philosophical figments of which we have already heard. Suspended animation may be possible in a complicated organism, but if we are to follow the philosophers down to a basal life-stuff, we cannot logically admit any factor into the problem but matter and life. In other words, the only admissible alternative is matter plus vitality or matter minus vitality.

This, then, brings us to the point to which my address of a year ago brought us,—to the impassable gulf between the not-living and the living. This is the perennial mystery of mysteries to whose brink every thorough scientist and every deep philospher sooner or later comes, but beyond whose thick darkness no human eye can see, and under whose appalling silence even the wisest man must stand dumb.

SYNOPSIS OF THE CRETACEOUS FORAMINIFERA OF NEW JERSEY.

PART I. REVIEW OF PREVIOUS INVESTIGATIONS.

BY ANTHONY WOODWARD.

(*Presented December 20th*, 1889.)

The embodiment of this paper is to bring together all the work that has been previously done, and the remarks that have been made on the Cretaceous Foraminifera of New Jersey, from 1833–1889, by giving a reproduction of such parts of the various interesting and valuable papers of Isaac Lea, Jacob Whitman Bailey, Samuel George Morton, Charles Lyell, William M. Gabb, Auguste Emanuel Reuss, Fielding Bradford Meek, Louis F. De Pourtales, Herr Hermann von Credner, Thomas Rupert Jones and William Kitchen Parker as are scattered through literature, not always accessible.

1833. ISAAC LEA. Contributions to Geology, 219, 220. Description of a new Genus of the Family *Spherulacea* of Blainville, from the Cretaceous deposit of Timber Creek, New Jersey.

GENUS PALMULA (nobis).

Description. Shell palmate, with angular striæ, which indicate the interior chambers ; aperture terminal.

Observations. Two specimens of the shell on which I propose to found this genus, were found by me, about four years since, in the Cretaceous deposit of Timber Creek, New Jersey. In its characters it approximates most closely to the genus *Saracenaria* of Defrance. Manuel de Malacologie, Blainville, 370. The oval form, the possession of a carina, and the absence of an aperture in that genus, prohibit our shell being placed with it. The *Palmula* also resembles the genus *Textularia* of the same author, and might, perhaps, with propriety be placed between these two genera.

P. sagittaria. Pl. vi., fig. 228.

The small figure is of the size of nature.

Description. Shell depressed, sagittate, rounded on the edges, with about six angular striæ, which indicate the interior chambers ; mouth terminal, oval, sublabiate, Diameter .05, Length .2. Breadth .1 of an inch.

Observations. The two specimens differ somewhat in outline, the larger one being more elliptical. In both the angular striæ become obsolete at the base, being most distinct on the superior part.

1841. J. W. Bailey. Fossil Foraminifera in the Green Sand of New Jersey. Amer. Journ. Sci. xli. 213, 214.

In a recent visit to the Cretaceous formation of New Jersey, he has brought to light the interesting fact that a large portion of the calcareous rock, defined by Prof. H. D. Rogers as the third formation of the upper secondary, is made up, at the localities where he examined it, of great quantities of microscopic shells, belonging to the Foraminifera of d'Orbigny, which order includes those multilocular shells, which compose a large part of the calcareous sands, etc., of Grignon and other localties, in the tertiary deposits of Europe. Since the minute multilocular shells above alluded to were discovered, Dr. Torrey and Prof. Bailey have together examined specimens of limestone from Claiborne. Alabama, and have found in them Foraminifera, of forms apparently identical with those occurring in New Jersey. None of this order, except the genus *Nummulite*. have heretofore been noticed in our green-sand formation.

1842. S. G. Morton. Description of some new species of Organic Remains of the Cretaceous Group of the United States. Journ. Acad. Nat. Sci., viii. 214, 215, pl. xi. fig. 5.

GENUS PLANULARIA.

P. cuneata. Pl. xi. fig. 5. Shell ovate, slightly angulated in the middle; one side slightly concave, with concentric lines, which are angular in the centre of the disk. Length three-tenths of an inch.

From the middle cretaceous strata of New Jersey, where it was found by Mr. Conrad.

No locality given.

1845. Charles Lyell. Notes on the Cretaceous Strata, of New Jersey and other parts of the United States bordering the Atlantic. Quart. Journ. Geol. Soc. Lond., i. 56, 57, 64.

In an excursion which I made in New Jersey, in September, 1841, in company with Mr. Conrad, we went first to Bristol, on the Delaware. next, by Bordentown, to New Egypt, and returned by Timber Creek, recrossing the Delaware at Camden.

In the upper or straw-colored limestones, I found on the banks of the Timber Creek, twelve miles southeast of Philadelphia, six species of corals. The same calcareous formation also abounds in Foraminifera, characteristic of the chalk, comprising, among others, the genera *Cristellaria*, *Rotalina* and *Nodosaria*.

I saw the formation in question, on the banks of Timber Creek, a stream which flows into the Delaware three miles below Philadelphia.

The principal locality is twelve miles southeast of Philadelphia, about a mile and a half south of the village of White Horse, Gloucester County, New Jersey.

Notice of the Foraminifera by Lyell. (Figures *Rotalina* and *Cristellaria*).

The above are figures of two genera of Foraminifera from the upper beds at Timber Creek, alluded to in the paper. I am not aware that any attention has hitherto been paid to the fossil foraminifera of American Cretaceous strata, to which I find no allusion in Dr. Morton's works. They are very abundant in the coralline rock of Timber Creek. Mr. Forbes has examined some of them for me, and these belong to the genera *Cristellaria*, *Rotalina* and *Nodosaria*. All these genera occur in the chalk of Europe. One of my American species of fossil *Cristellaria* is specifically identified by Mr. Forbes with *C. rotulata* of d'Orbigny, which occurs in England, France and Germany, ranging from the upper greensand to white chalk. It is another instance of species found most abundantly in Europe, recurring in American chalk. There are two other species of the same genus at Timber Creek, one of them very large. There are two species of *Nodosaria*. The *Rotalina*, which is very abundant, is closely allied to species of our chalk.

1845. CHAS. LYELL. Travels in North America, i. 64.

He found, in the upper, or straw-colored limestone, on the banks of the Timber Creek, twelve miles southeast of Philadelphia, six species of corals and several echinoderms, chiefly allied to upper cretaceous forms. The same calcareous stratum also abounds in Foraminifera, characteristic of the chalk, comprising, among others, the genera *Cristellaria*, *Rotalina* and *Nodosaria*.

1856. J. W. BAILEY. On the Origin of Greensand, and its formations in the Oceans of the present epoch. Proc. Bost. Soc. Nat. Hist., v. 365, 366.

The formation of the Greensand consists in a gradual green-colored, opal-like mass, which forms therein as a cast. It is a peculiar species of natural injection, and is often so perfect, that not only the large and coarse cells, but also the very finest canals of the cell-walls, and all their connecting tubes are thus petrified, and separately exhibited. By no artificial method can such fine and perfect injections be obtained.

He mentions among his observations, that the yellowish limestone of the cretacecus deposits of New Jersey occurring with *Teredo tibialis*, etc., at Mullica Hill, and near Mount Holly, is very rich in greensand casts of *Polythalamia* and of the tubuliform bodies above alluded to.

1860. W. M. GABB. Descriptions of New Species of American Tertiary and Cretaceous Fossils. Journ. Acad. Nat. Sci., ser. 2. iv. 402, 403, pl. lxix. figs. 40, 41.

I have recognized a number of species of foraminifera, in a marl from near Mullica Hill, N. J., of the same age as Timber Creek limestone (upper part of No. 5 of Meek and Hayden,) abounding in corals, the most common of which is *Eschara digitata*. The matrix is fortunately not so hard as that at Timber Creek, and both the corals and foraminifera are much better preserved. I shall not describe any at present, except the beautiful *Dentalina*, given below. I expect, however, at some not very

distant period to characterize them. I have not yet seen *Cristellaria rotula*, said by Lyell to occur at Timber Creek, although I have examined several hundred specimens.

DENTALINA, d'Orb.

D. pulchra. Pl. lxix, figs. 40, 41. Elongated, very slightly arcuate; cells large, more convex towards the large extremity; diameters of cells equal; surface marked by about ten heavy, longitudinal ribs; sutures obliterated; opening small, tubulate and inclined in the direction of the curve.

Dimensions. Length about .25 in., greatest diameter .03 in. Locality—Near Mullica Hill, N. J. My collection. Rare.

1861. A. E. REUSS. Die Foraminiferen des senonischen Grünsandes von New Jersey. Paläontologische Beiträge. Sitzungsberichte d. kais. Akad. d. Wissenschaft in. Wien., xliv. 334–342, pls. i–viii.

(Translation.)

The Foraminifera of the Cretaceous Greensands from New Jersey.

From the materials furnished me for examination, I have to thank Dr. Hörnes, Director of the Imperial Cabinet of Mineralogy at Vienna, Dr. Krantz of Bonn, and especially Prof. Ferd. Römer of Breslau. The specimens from the first two contained but few foraminifera; those from Prof. Römer were quite rich in the same. Unfortunntely, however, they were for the most part not well preserved and the more fragile forms were present only in fragments.

The following is a list of the species found. They all belong to the polymerous Foraminifera, and the few species which appear to me to be new, I have described and figured.

1. RHABDOIDEA, Schltz.

a) NODOSARIDEA (m.)

a) Nodosaria, d'Orb.

1. *N. polygona*, Rss. Zeitschr. d. deutsch. geolog. Gesellsch., 1855, 265, pl. vii. figs. 7, 8. Fragments, rare. They are very often found however, in the upper Cretaceous of Mecklenburg.

2. *N.* sp. with globular chambers, separated by deep sutures, which are covered with numerous fine longitudinal ridges. The first chamber is equal in size to the following one, and ends in a very short, central spine. I saw only a fragment in which the last chamber was wanting.

b) Dentalina, d'Orb.

1. *D. gracilis*, d'Orb. Mém. de la soc. géol. de France, iv. 1, 14, pl. i. fig. 5. Very rare elsewhere in the upper chalk formations down to the "Pläner." Very widely distributed.

2. *D. colligata*, N. sp. Pl. vii. fig. 4. Approaching many species of *Marginulina*. Little bent, obtuse below, with six to seven chambers,

the first small, rounded, and scarcely larger than the next, from which externally, it does not appear to be separated. The remaining chambers increase upward gradually in breadth, with unequal sides. The ventral side is somewhat more ventricose than the dorsal side, and is separated by very small and shallow oblique sutures. On the concave dorsal side, all the chambers are united, as it were, by a small, narrow, smooth, slightly elevated ridge, upon which the division of the chambers is scarcely visible. The first chamber shows a slight tendency to curve forward ; the last, which is very oblique, ends at the dorsal angle in a short thick spine. Very rare.

3. *D. Steenstrupi*, Rss. See page 326. Very rare.

4. *D. confluens*, N. sp. Pl. vii. fig. 5. The shell (Gehäuse), which may be 3 mm. long, is rather thick, slightly bent, sometimes compressed, and consists of seven chambers, in the first of which the boundaries are not to be made out from the external appearance. Only the last chambers, which are slightly higher than broad, are marked off by very shallow sutures. They decrease in size downwards, but slowly, the lower extremity however, diminishing abruptly to form the short spine, the latter being sometimes directed backwards. The chambers are covered with 16–20 very narrow abrupt, longitudinal ridges, these are often irregularly sinuous, and increase in number, from below upward, by the insertion of new ones, or, by bifurcation, they are separated by narrow deep furrows between them. The last, very oblique, chambers run out into a very short spine which almost points backward. Very rare.

b) Frondicularidea (m.)

Flabellina, d'Orb.

Fl. cordata, Rss. Sitzungsber. d. k. Akad. d. Wiss., xl. 216. Very rare.

2. CRISTELLARIDEA, Schltz.

Cristellaria, Lam.

a) **Marginulina**, d'Orb.

M. ensis, Rss. Die Verstein. der böhm. Kreideform., i. 29, pl. xii. fig. 13, pl. xiii. figs. 26 ,27. Very rare. Frequent, however, in the upper cretaceous of other countries down to the " Pläner." England, Westphalia, Bohemia, Galieia, etc. Sitzungsber. d. k. Akad. d. Wiss. in Wien., xl. 207.

b) **Cristellaria**, d'Orb.

1. *Cr. intermedia*, Rss. var. Die Verstein. der böhm Kreideform., i. 33, pl. xiii. figs. 57, 58, pl. viii. fig. 2. The American specimens differ from the Bohemian in forming a more distinct and larger spiral, and in having the last chambers separated by deeper sutures, while the limits of the first ones are not externally visible. Very rare.

2. *Cr. Baylei*. N. sp. Pl. vii. fig. 7. Diameter 0.77 mm. Shell circular, moderately compressed, lens-shaped, with a sharply, keeled dor-

sum. Nine narrow strongly arched chambers, with low, but well defined septa, which run together in a central, small, low, irregular umbilicate disk. Aperture oval, cut in deeply two-thirds of the way up, through the next to the last whorls, almost forked, margined on both sides by a narrow ridge. Very rare.

3. *Cr. rotulata*, Lam. sp. L. c. 326. Rare.

c) **Robulina**, d'Orb.

R. trachyomphala, Rss. Haidinger's gesamm. naturwiss. Abhdl. iv. 1, 34, pl. iii. fig. 12. Rare. More frequent in the mucronate marl of Nagorzani at Lemberg. Young individuals have only 5–6 chambers, and a very small indistinct umbilicate disk. Some specimens are slightly keeled at the back.

3. LITUOLIDEA (m.)

Haplophragmium, Rss.

1. *H.* sp. A nonionian form, with six arched chambers separated by deep sutures. Shell very rough with small, roundish nonionian aperture. Only one specimen.

4. ROTALIDEA, Schltz.

Rotalia, Lam.

1. *R. nitida*, Rss. Sitzungsber. d. k. Akad. d. Wiss. in Wien., xl. 222. Very rare. Elsewhere occurring in the " Mucronaten und Quadraten Schichten," and in the " Pläner."

2. *R. Micheliniana*, d'Orb. Mém. de la. Soc. géol de Fr., iv. 1, 31, figs. 1–3. Very rare to the " Pläner." Also occurring in the upper Cretaceous of other countries down.

3. *R. polyraphes*, Rss. Haidinger's gesamm. naturwiss. Abhdl., iv. 1, 35, pl. iv. fig. 1. Very rare. Common in the mucronate and quadrate layers, and in the " Pläner " of other countries, rare in the Cretaceous and in the Gault. Numerous localities are mentioned in the Sitzungsber. d. k. Akad. d. Wiss. in Wien., xi. 77

4. *R. Mortoni*, n. sp. Pl. viii. fig. 1. Common. Similar to *R. polyraphes*, Rss., and even more so to *R. lenticula*, Rss.—Die Kreideverstein. Böhmens, i. 35, pl. xii. fig. 17—but much larger than the last, more curved on the spiral side, with numerous and more narrow chambers. Diameter reaches 0.77 mm. The shell is depressed, lens-shaped, with an acute margin, both sides somewhat curved, the umbilicate side more strongly. On the spiral side usually only the last whorl is separated by a narrow but rather deep suture ; the older two are but seldom distinguishable externally, and are covered by a calcareous incrustation, which is permeated by porous canals of varied sizes ; nine to ten chambers in the last whorl, of which only the last two or three are separated by distinct sutures. They are only slightly curved. The others are usually indistinguishable externally. The umbilicate side shows in its centre either a very

narrow and shallow depression or none at all, or in place of it a small, flat disk-like elevation which is very finely porous. The chambers appear upon this surface as narrow triangles, somewhat curved, the sutures more distinct, as shallow lines. The porous canals, of the spiral side, are somewhat wider than the umbilical side. The aperture is a short opening situated far below the peripheric border.

5. *R. Karsteni*, Rss. Zeitschr. d. deutsch. geolog. Gesellsch., 1855, 273, pl. ix. fig. 6. Very rare.

Rosalina, d'Orb.

1. *R. ammonoides*, Rss. Reuss in Haidinger's gesamm. naturwiss. Abhdl., iv. 1, 36, pl. iv. fig. 2. Very rare. More frequent elsewhere in the upper chalk-beds, down to the Cretaceous.

2. *R. Bosqueti*, n. sp. L. c. 316, pl. iii. fig. 1. Very rare. Also in the chalk-tufa of Mastricht.

Truncatulina, d'Orb.

1. *Tr. convexa*, Rss. L. c. 331. Very rare. Is very variable, often bent and not always so arched as in the figure referred to on the above-mentioned page. Pl. iv. fig. 4.

2. *Tr. De Kayi*, n. sp. Pl. vii. fig. 6. Very rare. The shell which is only 0.49 mm. in diameter, is circular; the spiral side smooth, and only the last chamber slightly arched, with three whorls and a wrinkled upper surface. The umbilicate side arched, regular, with eight small curved chambers, of which only the last are marked off by distinct sutures. The surface coarsely punctate.

5. POLYMORPHINIDEA, d'Orb.

Bulimina, d'Orb.

1. *B. tortilis*, n. sp. Pl. viii. fig. 3. Frequent. A peculiar small species, at the most 0.52 mm. long, triangular pyramidal, with somewhat concave sides, and three longitudinal edges, which gradually become thicker and more obtuse from below upward, and which do not run directly up, but turn gradually in their course so that the whole shell seems twisted. Five whorls, the first ones very small, each consisting of three small semilunate curved chambers; the older ones externally, scarcely separable, slightly arched; the latter ones rapidly increasing in size, and becoming more strongly arched. The orifice, a short elliptical aperture, beginning immediately under the obtuse point of the last chamber, and running down toward the lateral surface of the shell.

2. *B.* sp. indet. Similar to *B. pupoides*, d'Orb.,—Foram. foss. du bass. tert. de Vienne, pl. ii. figs. 11, 12,—with an elongated, smooth irregular shell, with a roundish transverse section. Only one incomplete specimen.

POLYMORPHINA, d'Orb.

a) **Globulina**, d'Orb.

1. *Gl. globosa*, v. Mstr. L. c. 318. Very rare.

2. *Gl. lacrima*, Rss. Haidinger's gesamm. naturwiss. Abhdl., iv. 1, 43, pl. v. fig. 9. Very rare, as in the mucronate marls of Lemberg.

b) Guttulina, d'Orb.

G. cretacea, Alth. L. c. 319. Very rare. A more slender, strongly pointed variety.

c) Polymorphina, d'Orb.

1. *P. subrhombica*, n. sp. Pl. vii. fig. 3. Very rare. The shell 0.98 mm. long, rhomboidal in outline, obtusely pointed to the same extent on both sides, the transverse section narrowly elliptical, the margins angular. There are to be seen externally only four slightly arched, double rows of alternating oblique chambers. Sutures linear, obscure, especially the lower ones. Orifice radiated. The species closely resembles *P. ovata*, d'Orb. Foraminifera du bass. tert. de Vienne, pl. xiii. figs. 1–3. From the miocene strata of the Vienna Basin, and with the oligocene.

2. *P. regularis*, v. M. Reuss, Sitzungsber. d. k. Akad. d. Wiss., xviii. 247, pl. vii. figs. 70–73. It is, however, sufficiently distinct from both.

From the preceding list it will be seen that I have thus far found 28 species of Foraminifera in the Cretaceous Greensand of New Jersey. From the many indeterminable fragments of which I could not possibly determine the genus, the number is undoubtedly greater. From the above number three species, which could not be positively decided on, must be omitted therefore, leaving only 25 species, of which 7—*Dentalina confluens*, *Dentalina colligata*, *Cristellaria Baylei*, *Rotalia Mortoni*, *Truncatulina De Kayi*. *Bulimina tortilis* and *Polymorphina subrhombica*—have, hitherto, not been discovered elsewhere. There remains for comparison only 18 species They are all collected in the upper Cretaceous of other countries, and 5 of them—*Robulina trachyomphala*, Rss., *Rosalina Bosqueti*, Rss., *Truncatulina convexa*, Rss., *Globulina lacrima*, Rss., and *Guttulina cretacea*, Alth.—are exclusive in these beds.

Four species—*Nodosaria polygona*, Rss., *Dentalina Steenstrupi*, Rss., *Cristellaria intermedia*, Rss., and *Rotalia Karsteni*, Rss.—are found in other countries in the Cretaceous beds also. Five species—*Dentalina gracilis*, d'Orb., *Rotalia nitida*, Rss., *Rotalia Micheliniana*, d'Orb., *Globulina globosa*, v. Mstr. and *Marginulina ensis*, Rss.—extend into the "Pläner." *Globulina globosa*, however, also extends upward into the Oligocene and Miocene Tertiary beds *Rosalina ammonoides* and *Fallina cordata*, Rss. extend from their vertical range and mucronate bed into the Cretaceous, while *Cristellaria rotulata*, Lam. sp. and *Rotalia polyraphes*, Rss. are found as low as the "Gault."

In the Cretaceous Greensand of New Jersey the Rhabdoidians and the Nodosaridians are represented by 6, the Frondicularidians by 1, the Cristellaridians by 5 species, the Lituolidians by 1, the Rotalidians by 9, and finally the Polymorphinidians by 6 species. The Family of Rotalidians, therefore, furnishes the greatest number of species, while the Rhabdoidians and Polymorphinidians follow next in order. The most numerous species are those belonging to the genera *Rotalia* (5) and *Dentalina* (4). With

the exception of *Rotalia Mortoni* and *Bulimina tortilis* (both new species), of which numerous examples are found, the remainder appear seldom.

Most of them however are very rare. With the exception of the peculiarly formed *Bulimina tortilis*, all the remaining species offer nothing remarkable in their external appearance They belong to the ordinary, universally distributed, well-known types.

The reference in the description of *Cris. rotulata*: for which the reader is refered to p. 326, is as follows:

1. *Cr. rotulata*, Lam. sp, d'Orb. mém. de la Soc. géol. de France, iv. 1, 26, pl. ii. figs. 9, 15–18. This species, which is commonly distributed in the Cretaceous, occurs quite frequently, also in the chalk of Rügen, and in specimens of unusual size. The orifice is not stellate in any of the specimens at hand. In one, after often repeated and close examination, I could not discover any larger orifice.

I have mentioned numerous localities where this cosmopolitan species can be found, in my Monograph on the Foraminifera of Westphalian chalk formation. Sitzungsber. d. k. Akad. d. Wiss. in Wien., xl. 70.

The description of *R. Bosqueti*. on p. 316, is as follows:

2. *R. Bosqueti*, n. sp. Pl. iii. figs. 9, 1. Rare. Differing from the ordinary *Rosalina* type, more like many Rotalidæ with flat oval shells 0.7 mm. long, broadly oval, strongly depressed, rounded angular edges, very moderately arched spiral side, and somewhat pressed in umbilicate surface. The spiral side shows but two whorls, of which the second increases rapidly in breadth, and presents 7–8 rather broad, slightly curved chambers, which are separated by linear partially obscure sutures. The central volution not externally divided into chambers on the underside, which has a moderately broad umbilicus. Only the last large chamber somewhat protruded. The remainder of the shell is somewhat hollowed out toward the centre. The slightly curved suture narrow, but rather deep. The surface of the shell covered with quite large pores.

1864 F. B. MEEK. Check-List of the Invertebrate Fossils of North America. Cretaceous Formation, Smithsonian Mis. Coll., 177, p. 1.

SUBKINGDOM PROTOZOA.

CLASS RHIZOPODA.

ORDER FORAMINIFERA.

LAGENIDÆ.

2. *Phonemus* (*Cristellaria*) *rotulatus*, (d'Orb.?) Meek.
3. *Phonemus* (*Flabellina*) *cuneatus*, (Morton) Meek.
4. *Phonemus* (*Flabellina*) *sagittarius*, (Lea) Meek.
5. *Phonemus* (*Dentalina*) *pulcher*, Gabb.

NOTES AND EXPLANATIONS. (Page 31.)

(Gretaceous.)

3 = *Planularia cuneata*, Morton, Jour. Acad. Nat. Sci., viii. 214, pl. xi. fig. 5.

4 = *Palmula sagittaria*, Lea, Am. Phil. Soc., (1833) Contrib. Geol., 218, pl. vi. Dr. Carpenter unites *Cristellaria*, *Flabellina*, *Dentalina*, *Nodosaria &c.*, as members of a single genus, for which he uses the name *Nodosaria*. It may be at least convenient, however, to retain these names in a subgeneric sense ; but, in either case, we should think Montfort's older name *Phonemus*, should stand for the entire group.

6 and 7.—I have not been able to find by whom these two species were described, but believe it was by Ehrenberg.

1868. F. B. Meek. Synopsis of the Invertebrate Fossils of the Cretaceous Formation of New Jersey. Appendix A., Geology of New Jersey, 721.

SUBKINGDOM PROTOZOA.

CLASS RHIZOPODA.

ORDER FORAMINIFERA.

LAGENIDÆ.

Phonemus (*Flabellina*) *cuneatus*, Morton, sp. Meek. Cretaceous check-list, 1. *Plannlaria cuneata*, Morton, Jour. Acad. Nat. Sci., ser. i. viii. pl. xi. fig. 5.

Phonemus (*Flabellina*) *sagittarius*, Lea, sp. Meek. Cretaceous check-list, 1. *Palmula sagittaria*, Lea, Amer. Philos. Soc., (1833) Contrib. Geol., 218, pl. vi. fig. 228.

Phonemus (*Dentalina*) *pulcher*, Gabb. Jour. Acad. Nat. Sci., ser. 2, iv. 402, pl. xviii. figs. 40, 41. Meek Cretaceous check-list, 1.

1869. Louis F. De Pourtales. The Gulf Stream. Characteristics of the Atlantic Sea-bottom off the Coast of the United States. U. S. Coast Survey, 1869. (1872) 221, 222.

Off Long Branch and off Rockaway Beach, near the entrance to New York Bay, the sand contains a large mixture of black grains. They are greensand grains or glauconite, casts of the shells of Foraminifera from the greensand formation of New Jersey, and have been washed out, either from the shore or from an outcropping of the beds under the sea-level.

1870. T. Rupert Jones, & W. Kitchen Parker. On the Foraminifera of the Family Rotalinæ (Carpenter) found in Cretaceous Formations ; with Notes on their Tertiary and Recent Representatives. Quart. Journ. Geol. Soc. Lond., xxviii. 103–132.

On page 108 they refer to A. E. Reuss.——— Die Foraminiferen des senonischen Grünsandes von New Jersey, Palæontologische Beiträge, Sitz. math.—naturw. d. k. Akad. Wiss. in Wien, xliv. 334–340 (1861).

The following synonymy is made.

1. Pl. viii. fig. 1. *Rotalia mortoni* = *Planorbelina Ungeriani.* Thick sub-variety.
2. Pl. vii. fig. 6. *Truncatulina Dekayi* = *Truncatulina lobatula.* Neat form.

On page 121.—" *Pulvinulina repanda* (proper) is represented in the Chalk of Masstricht, but in none of the other cretaceous beds. It is rare in the Tertiaries of our Table (occurring only in the Pliocene), but is scattered throughout the Atlantic. *P. auricula* existed in the Nummulitic sea, abounded in the mid-Tertiary times, and, living now, is abundant in some places ; but it is wanting in the chalk. *P. Menardii*, however, was one of the early representatives of the genus. In New Jersey (North America) it occurs in the Greensand. With us it begins with the white chalk, and has continued with increased prolificness till now. *P. Schreibersii* occurs sporadically in the Greensand of New Jersey."

On page 123, pl. ii. —— the Range of Recent, Tertiary, and Cretaceous Rotalinæ. You will notice three species as being found in the Greensand of New Jersey. *Planorbulina conical*, *P. nautiloid*, and *P. plano-convex*.

1870. HERMAN VON CREDNER. Die Kreide von New Jersey. Zeits. d. D. Geol. Ges., xxii. 191–251.

This article is a general review of the Cretaceous formation of New Jersey, Geological and Palæontological. On page 214 the author gives under Amorphozoa a description of *Flabellina cordata*, Reuss, and *Nodosaria sulcata*, Nils. of which the following is a translation.

Flabellina cordata, Reuss. Böhm. Kr., i. 32, pl. viii. fig. 39.
Frondicularia ovata, Röemer, Kr., 96, pl. xv. fig. 9.

Elliptical, narrowly compressed, about 15 chambers with bow shaped partition-walls ; the first, smallest chamber slightly nodose arched.

Rare in the bryozoan beds at Brownville.

Nodosaria sulcata, Nils.

Römer, Kr., 95.

Nod. Zippei, Reuss. Böhm. Kr., i. 25, pl. viii. fig. 1.

This handsome bodkin-shaped elongated foraminifer is on an average marked by 12 deep constrictions and appears in examples 18 mm. long. The small central, beak-shaped extension of the uppermost chamber and its aperture for the emission of the sarcode are seldom preserved.

Common in the bryozoan bed at Brownville and Turtle Hill.

N. B.—To follow :

Part II. Original Investigations, and remarks.

This part of the paper will consist of the determinations, additions and remarks on the various species found in material collected at Mullica Hill, Timber Creek, New Egypt and several other localities.

NOTES ON ENCLOSING IN COLLODION SECTIONS OF OBJECTS EMBEDDED IN PARAFFIN, AND REGARDING PROVISORY OBJECT-SUPPORT.

BY LUDWIG RIEDERER.

(*Read December 6th*, 1889.)

When working with serial sections for the study of the cellular constitution of animal organs, or for the study of the relative position of the different organs in the body of an animal, the observer often secures a surprising number of sections, usually of large size. As it is possible to inspect these sections only after they are on the slide and finished, the amount of slides and cover-glasses employed, as well as that of time and labor expended is considerable. Consequently only one section out of a smaller or larger number is mounted. It takes some time to finish the slides for inspection, and then it may be found desirable to be able to inspect more of the sections of a certain part of the series.

How then is it possible to preserve and to keep in order the sections, so that, when needed, the desirable ones can be picked out and be found in good condition? It will not do to leave sections lying on the paper, where they are first deposited from the knife, even if they are so kept in a box. The slightest current of air will blow them away, and movement of the box will displace them. Besides this, sections not covered by a proper substance will deteriorate by exposure to the air. Many researches have been made, with more or less of success, to attain the desired end.

I wish to report to some extent the method worked out by Prof. H. Straper of Freiburg, Baden, Germany, and published in the last number of *Zeitschrift für Wissenschaftliche Mikroskopie*, Vol. VI. The article is entitled, "About the treatment of sections of objects embedded in paraffin." Three steps are observed in the method: First; enclosing sections in a film of collodion. Second; placing them on provisory supports. Third; handling the sections while enclosed in collodion, in case the object has not already been stained. It is about the first and second steps that I intend to speak, leaving the third for another time.

The consecutive steps here described are for objects already stained. For enclosing the sections in a film of collodion, there is needed, in the first place, a thin paper of even surface, and evenly saturated with the smallest sufficient quantity of wax or paraffin. This treatment will prevent the solution of collodion from entering the body of the paper. Two solutions of collodion of different composition are used. No. 1 consists of two parts of collodion and one part of castor-oil. No. 2 consists of equal parts of each, all by weight. By means of a large, soft brush a coat of collodion, No. 1, is spread upon the paraffin-paper. On this coat the sections, intended to be enclosed, are laid in order, where they receive a full coat of collodion, No. 2, the presence of air-bubbles being carefully avoided. Then, before bubbles of ether in the interior of the collodion may begin to form, the paper, carrying collodion and sections, is immediately immersed in a bath of spirit of turpentine. The spirit of turpentine hardens the collodion, by extracting the ether, alcohol and castor-oil contained in the solution. Slightly warming the bath quickens the process. The coating of collodion, after immersion in turpentine, first appears milky white, but presently it becomes transparent and colorless, and then the hardening is done.

Now the film of collodion lies isolated in the paper, out of which the paraffin or wax is dissolved by the turpentine. If, while laying the sections on the collodion, a small piece of paper, bearing the number of the adjoining section, is occasionally inserted, this also is enclosed in the film and helps to distinguish sections afterwards desired. The film being hardened and isolated, sections desired for permanent mounting and inspection can be easily selected. They are cut out by means of scissors or knife, and mounted in the regular way in balsam, noting the number or other mark of any section on the label of the slide.

The sections not selected for immediate permanent mounting must then be enclosed in rosin for preservation. To do this take the strips of paper, on which the collodion films rest, out of the turpentine bath ; let the oil drain off as much as possible; transfer them to filtering paper, and remove the surplus oil. The film containing the sections is then covered, by means of a soft brush, with a thick layer of a strong solution of light-colored

rosin in oil of turpentine. The oil of turpentine will be mostly absorbed by the film. Thin writing or tracing paper is then laid on the film, avoiding bubbles. On carefully raising this paper the film will adhere, and can be lifted off the paper it lay on first. A coat of the rosin is then applied to the lower side of the film, and the old paper, or tracing paper put over it. It is allowed to dry on the filtering paper. In case rosin should blot through the paper it is removed with turpentine. Remarks can be written on the covering paper, and the whole plate, or temporary support, is preserved in a portfolio between filtering paper, free from pressure and open to the access of air.

In holding such a plate against the light, it is possible to see at once the coarser items. For inspection under the microscope, the plate is put between a slide and cover-glass, adding oil, creosote, &c. to make the whole more transparent. Whenever then it is desirable to mount permanently single sections, or whole series of them, corresponding pieces of the provisory support are cut out and immersed in the turpentine bath. The rosin being dissolved, the film is separated from the covering paper, and can be mounted in the regular way. On the label of the slide can be marked the numbers, corresponding with the numbers embedded in the film with the sections. In this way it is possible to keep a large number of sections in good condition, easily distingüishable, and always ready for permanent mounting.

PROCEEDINGS.

Meeting of December 6th, 1889.

The Vice-President, Mr. P. H. Dudley, in the chair.

Thirty persons present.

The following Commitees were appointed by the chair:

On Annual Reception; Walter H. Mead, Charles S. Shultz, William Wales:

On Nominations of Officers; F. W. Devoe, F. W. Leggett, William G. De Witt.

Mr. L. Riederer read a Paper, entitled "Notes on enclosing in collodion sections of objects, embedded in paraffin, and regarding provisory support." This Paper Mr. Riederer illustrated

by a demonstration of the process before the Society, and it is published in this number of the JOURNAL, p. 56.

OBJECTS EXHIBITED.

1. A new ½ inch Powell and Lealand Objective: by ALBERT MANN, JR.

2. A "C" Eye-piece of Powell and Lealand, made from the "New Glass": by WILLIAM G. DE WITT.

3. A "C" Eye-piece of Zentmayer: by WILLIAM G. DE WITT.

4. *Drosera rotundifolia*, with captive insect: by GEO. C. F. HAAS.

5. *Utricularia*, with captive insect: by GEO. C. F. HAAS.

6. Diatoms of the genus *Hyalodiscus:* by E. A. SCHULTZE.

7. Diatoms of the genus *Rhizosolenia:* by E. A. SCHULTZE.

8. Spherules from slag of blast-furnace, showing multiple images.

9. Spicules from disintegrated cherty strata; polarized.

10. Quartz crystals from surface of iron ore (Hematite); polarized.

11. Section of fossil Coral; polarized.

12. Diatoms from the lake, creek and springs of Birmingham, Alabama.

13. Selected Diatoms from the same.

Nos. 8–13, inclusive, were prepared by K. M. Cunningham, of Birmingham, Alabama, Corresponding Member of the Society, and were exhibited by J. L. ZABRISKIE.

The Corresponding Secretary read a communication from Mr. Cunningham, containing information on many points of interest in the slides prepared by him, and exhibited, as stated above, and donating to the Society the said slides, together with the following objects and material:

Natural plate of crystals from bituminous coal of Birmingham.

The same, uncovered, showing iridescence by slanting light.

Nodule of fossil coral from Birmingham.

A packet of joints of encrinite stems and crystals from weathered limestone of Birmingham.

Sand from disintegrated chert.

Hollow grains from weathered limestone.

Spherule dust from blast-furnace.

Nodule of chert with spicules.

Calcispheræ in fossiliferous limestone, polished on two sides, from Llangellen, Wales.

Microphotograph, containing forty-eight portraits.

In his communication, Mr. Cunningham stated, that the selected Diatoms—exhibit No. 13—were transferred directly from a strewn slide to the exhibiting slide by the aid of a "Kain's Mechanical Finger," attached to a Beck's ½ inch objective, the slide being manipulated by the left hand, and the bristle being directed into the field from the left-hand side. This method counteracts the effect of reversal of image, enabling every desired movement to be accomplished with ease and certainty. The right hand assists in racking the Diatom from the slide, high enough to clear the edge of the cover-glass, upon which the Diatoms are to be fixed. Very minute species are selected and isolated by this means. And further, that the specimen of fossiliferous limestone from Wales, showing a profusion of Polycystinous bodies—Calcispheræ—may be prized as a relic, from the fact that it was given by Mr. Shrubsole of Chester, England—who first described it to the microscopical world—to Dr. Stolterforth, the eminent diatomist of Chester, who, in turn, gave the rough specimen to Mr. Cunningham.

Meeting of December 20th, 1888.

The President, Mr. Charles F. Cox, in the chair.

Twenty-seven persons present.

The Corresponding Secretary read a communication from the Hon. Marshall D. Ewell, LL.D., Corresponding Member of the Society, entitled "Amplification in Micrometry." This communication is published in this volume of the Journal, p. 4.

Mr. Anthony Woodward read, by title, a Paper, entitled "Synopsis of the cretaceous Foraminifera of New Jersey. Part 1. Review of previous investigations." This Paper is published in this number of the Journal, p. 45.

OBJECTS EXHIBITED.

1. Diatoms from Storen, containing *Suriella spiralis*: by Charles S. Shultz.

2. The Diatom, *Cymatopleura nobilis*: by Charles S. Shultz.

3. The Diatom, *Rhaphidodiscus Febigerii*: by GEO. C. F. HAAS.

4. Scales of 30 varieties of South American Lepidoptera: by THOMAS B. BRIGGS.

5. Monazite sand from Brazil: by THOMAS B. BRIGGS.

6. Section of Hydro-magnesite, showing radiating crystallization, from Hoboken, N. J.: by JAMES WALKER.

7. Radiating crystals of Hydro-magnesite from Hoboken, N. J.: by GEO. E. ASHBY.

8. Section of silicious Geode from the sub-carboniferous shales of Warsaw, Illinois: by J. D. HYATT.

9. Section of silicious fossil Coral, *Favosites*: by J. D. HYATT.

10. *Actinophrys sol*: by STEPHEN HELM, of 417 Putnam avenue, Brooklyn, N. Y.

Mr. Hyatt described his exhibits with the employment of black-board sketches, and stated that the geodes from Warsaw are of all sizes, from one-half of an inch to a foot or more in diameter, and, when broken, they are generally found to be hollow, with the cavity lined with crystals of calcite or quartz. As the formation in which they occur, is entirely calcareous it is not a little interesting to observe, as in this section, the complete molecular change which some of them have undergone. The side of the section representing the exterior is chalcedonic, for the depth of about one-eighth of an inch, showing the radiating fibrous structure and peculiar polarization of that mineral. The interior wall is compact crystalline quartz.

The section of *Favosites* is also completely metamorphosed. The cell-walls of the coral and the structure for a short distance inward are chalcedony, while the interior of each cell is entirely filled with microscopic quartz crystals.

Mr. Helm described his exhibit, and also reported, that on a late occasion he kept a female *Daphnia* in a minute drop of water in a live-box over night, and that on the next morning—after an interval of about eleven hours—he found her still living, and having produced fourteen living young, "all the very image of their mother."

MEETING OF JANUARY 3D. 1890.

The President, Mr. Charles F. Cox, in the chair.

Twenty-nine persons present.

Miss Mary A. Booth, of Longmeadow, Mass., was elected a Corresponding Member of the Society.

The Committee on Nominations of Officers, appointed at the meeting of December 6th, 1889, reported their nominations of the persons who were unanimously elected, as is stated below.

The President appointed as Tellers of the election of Officers Mr. H. W. Calef, and the Rev. Geo. C. F. Haas.

The annual Reports of the Treasurer and of the Committee on Publications were presented and adopted.

The President, Mr. Charles S. Cox, delivered his Annual Address, entitled "Protoplasm and the Cell Doctrine." This Address is published in this number of the JOURNAL, p. 17.

OBJECTS EXHIBITED.

1. The Diatom, *Rhaphidodiscus Febigerii*, Smith: by E. A. SCHULTZE.

2. Alimentary tube of the Blue-bottle Fly, *Musca* (*Lucilia*) *Cæsar*, L., exhibited in its entire length from œsophagus to rectum, with some of the neighboring organs, as glands, malpighian vessels, tracheæ and ovarian tubes containing eggs: by L. RIEDERER.

The President announced the closing of the polls, and declared the result of the balloting to be the election of the following persons as Officers of the Society for the present year:

President, P. H. DUDLEY.

Vice-President, J. D. HYATT.

Recording Secretary, BASHFORD DEAN.

Corresponding Secretary, J. L. ZABRISKIE.

Treasurer, CHARLES S. SHULTZ.

Librarian, LUDWIG RIEDERER.

Curator, WILLIAM BEUTTENMÜLLER.

Auditors, F. W. DEVOE, W. R. MITCHELL, F. W. LEGGETT.

MEETING OF JANUARY 17TH, 1890.

The President, Mr. P. H. Dudley, in the chair.

Twenty-five persons present.

The President delivered his Inaugural Address.

Mr. Alfred L. Beebee, was elected a Resident Member of the Society:

Mr. Charles F. Cox gave notice of a proposed amendment of Article X of the By-Laws of the Society, striking out the words "roll-call," wherever they occur in said Article.

On motion, the resignation of the members of the Committee on Annual Reception, because of their inability to devote their time to the labor necessarily required from such Committee, was accepted.

The President appointed the following persons as Committee on Annual Reception: Charles F. Cox, Anthony Woodward, James Walker.

The following were appointed as a Committe to procure six objectives, of moderate power and cost, for the use of the Society: J. D. Hyatt, J. L. Zabriskie and William G. De Witt.

The following were appointed as the Committee on Publications: J. L. Zabriskie, William G. De Witt, Walter H. Mead, John L. Wall and George E. Ashbey.

OBJECTS EXHIBITED.

1. Sections of Basalt, containing native iron, from Ovifak, Greenland: by JAMES WALKER.

2. The fungus, *Sporocybe cellare*, Peck, new species, showing capitulum and spores: by J. L. ZABRISKIE.

3. Spiral tracheids of Yellow Pine, *Pinus palustris*, Mill.: by P. H. DUDLEY.

4. Spiral tracheids of White Cedar, *Chamæcyparis sphæroidea*, Spach: by P. H. DUDLEY.

Slides of diatomaceous deposits from the Yellowstone Geyser region: by C. HENRY KAIN;

5. Deposit from the Yellowstone Lake.

6. Deposit from Norris's Meadow.

7. Deposit from Geyser Meadow.

8. Deposit from Nez Perces Creek.

9. Deposit (amorphous silica) from Sulphur Hill.

Mr. Dudley read a Paper describing his exhibits.

Mr. Kain stated concerning his exhibits, that this material from the Yellowstone Geyser region was presented to him by Mr. Walter Harvey Weed, of the U. S. Geological Survey. The diatoms contained are ordinary fresh-water forms, but there are

some points of more than ordinary interest connected with them.

Mr. Weed has described—Botanical Gazette, xiv, 117—the vast diatom-marshes of the Yellowstone National Park, which owe their origin to the fact that the water from the geysers is highly charged with silica.

The crude material appears to be composed of vast numbers of diatoms, associated with the dried gelatinous matter, which usually accompanies such deposits. The usual methods of cleaning the diatoms by boiling in the mineral acids, however, almost entirely fail with these deposits, for the reason that what appears at first to be only the usual accompanying organic matter is in reality silicious sinter. An attempt to get rid of this by boiling the deposit in caustic potash resulted in the destruction of the diatomaceous frustules, while the sinter itself was scarcely attacked.

The deposits are quite similar in regard to the character of the species found, the largest forms, however, occurring in the cooler waters of the Yellowstone Lake.

This subject was discussed by Mr. E. A. Schultze and Dr. N. L. Britton.

Mr. Kain donated the five slides of his exhibit to the Cabinet of the Society.

PUBLICATIONS RECEIVED.

The Microscope: Vol. IX., Nos. 10, 12—Vol. X., No. 2 (December, 1889, February, 1890).

The American Monthly Microscopical Journal: Vol. X., Nos. 10, 12—Vol. XI., Nos. 1, 2 (October, 1889—February, 1890).

The Microscopical Bulletin and Science News: Vol. VI., No. 6 (December, 1889).

Anthony's Photographic Bulletin: Vol. XX., No. 23—Vol. XXI., No. 5 (December 14, 1889—March 8, 1890).

Entomologica Americana: Vol. V., No. 10—Vol. VI., No. 3 (October, 1889—March, 1890).

Psyche: Vol. V., Nos. 160-166 (August, 1889-February, 1890).

Insect Life: Vol. II., Nos. 5-8 (November, 1889-February, 1890).

Bulletin of the Torrey Botanical Club: Vol. XVI., No. 12—Vol. XVII., No. 2 (December, 1889-February, 1890).

The Botanical Gazette: Vol. XIV., No. 12—Vol. XV., No. 1 (December, 1889-January, 1890.)

The School of Mines Quarterly: Vol. XI., Nos. 1, 2 (November, 1889–January, 1890).

San Francisco Microscopical Society, Proceedings (December 11, 1889).

Natural Science Association of Staten Island, Proceedings (December 12, 1889–February 13, 1890).

Johns Hopkins University, Studies from the Biological Laboratory: Vol. IV., Nos. 5, 6 (November, 1889–February, 1890).

New York State Museum, Fifth Report of the Entomologist (1889).

American Academy of Arts and Sciences, Boston; Proceedings: Vol. XXIII., Part 2 (1888).

The West American Scientist: Vol. VI., No. 49 (November, 1889).

Kansas Academy of Science, Transactions (1887–88).

Washburn College Laboratory, Bulletin: Vol. II., No. 10 (December. 1889).

Agricultural Experiment Station, Alabama; Bulletins, Nos. 8, 10 (November, 1889, January, 1890); Science Contributions, Vol. I., No. 1 (December, 1889).

Cornell University College of Agriculture, Bulletins: Nos. 11–15 (November–December, 1889).

Agricultural College of Michigan, Bulletins: Nos. 54–56 (October, 1889–February, 1890).

Museum of Comparative Zoölogy, Cambridge, Annual Report (1888–9).

The Brooklyn Medical Journal: Vol. IV., Nos. 1–3 (January–March, 1890).

The Satellite: Vol. III., Nos 4–6 (December, 1889–February, 1890).

The Hahnemannian Monthly: Vol. XXIV., No. 12—Vol. XXV., No. 3 (December, 1889–March, 1890).

The Medical Analectic and Epitome: Vol. VI., No. 49—Vol. VII., No. 1 (December 5, 1889–January, 1890).

Indiana Medical Journal: Vol. VIII., Nos. 6–8 (December, 1889–February, 1890).

The Electrical Engineer: Vol. IX., Nos. 97, 98 (January, February, 1890).

The American Lancet: Vol. XIII., No. 12—Vol. XIV., No. 2 (December, 1889–Februray, 1890).

The Pacific Record of Medicine and Surgery: Vol. IV., Nos. 5–7 (December, 1889–February, 1890).

National Druggist: Vol. XV., No. 12—Vol. XVI., No. 5 (December 15, 1889–March 1, 1890).

Mining and Scientific Review: Vol. XXIII., No. 21—Vol. XXIV., No. 9 (December 5, 1889–February 27, 1890).

The Canadian Record of Science: Vol. III., No. 8—Vol. IV., No. 1 (October, 1889–January, 1890).

Nova Scotian Institute of Natural Science, Proceedings: Vol. VI., Part 2—Vol. VII., Part 3 (1883–89).

The Ottawa Naturalist: Vol. III., No. 3 (October, 1889).

The Canadian Institute: Proceedings. Vol. VII., No. 1 (October, 1889); Annual Report (1889).

Natural History in Elementary Schools; by H Hensoldt, Ph. D. (1890)

A Naturalist's Rambles in Ceylon; by H. Hensoldt, Ph. D. (1889).

The New York Free Circulating Library, Annual Report (1889).

Grevillea: No. 86 (December, 1889).

Journal of the Royal Microscopical Society: 1889, Parts 6, 6a; 1890, Part 1.

The Journal of Microscopy and Natural Science: Vol. III., No. 1 (January, 1890).

The Journal of the Quekett Microscopical Club: Vol. IV., No. 26 (January, 1890.

The Naturalist: Nos. 173–175 (December, 1889–February, 1890).

Field Naturalist's Club of Victoria, Ninth Annual Report (1888–89).

The Victorian Naturalist: Vol. VI., Nos. 7–9 (November, 1889–January, 1890).

Bulletin de la Société Belge de Microscopie: Vol. XVI., Nos. 1–3 (October–December, 1889).

Naturwiss. Verein d. Reg.-Bez. Frankfurt a O.: Mittheilungen, Vol. VII., Nos. 6–7 (September, October, 1889); Societatum Litteræ, Vol. III., Nos. 7–8 (July–August, 1889).

Wissenschaftlichen Club in Wien: Monatsblätter, Vol. XI., Nos. 2–4 (November, 1889–January, 1890); Ausserordentliche Beilage, Vol. XI., Nos. 2–4.

Société Royale de Botanique de Belgique: Comptes-Rendus (November 9, 1889–February 8, 1890); Bulletin, Vol. XXVIII., No. 2 (1889).

Bolletino della Società Africana d' Italia: Vol. VIII., Nos. 5, 6 (May, June, 1889).

Nuovo Giornale Botanico Italiano: Vol. XXII., No. 1 (January, 1890).

Kongl. Svenska Vetenskaps-Akademien, Transactions: Vol XII., Nos. 3, 4 (1887, 1888).

Die Grundlagen der Bakteriologie; by A. P. Fokker (1889).

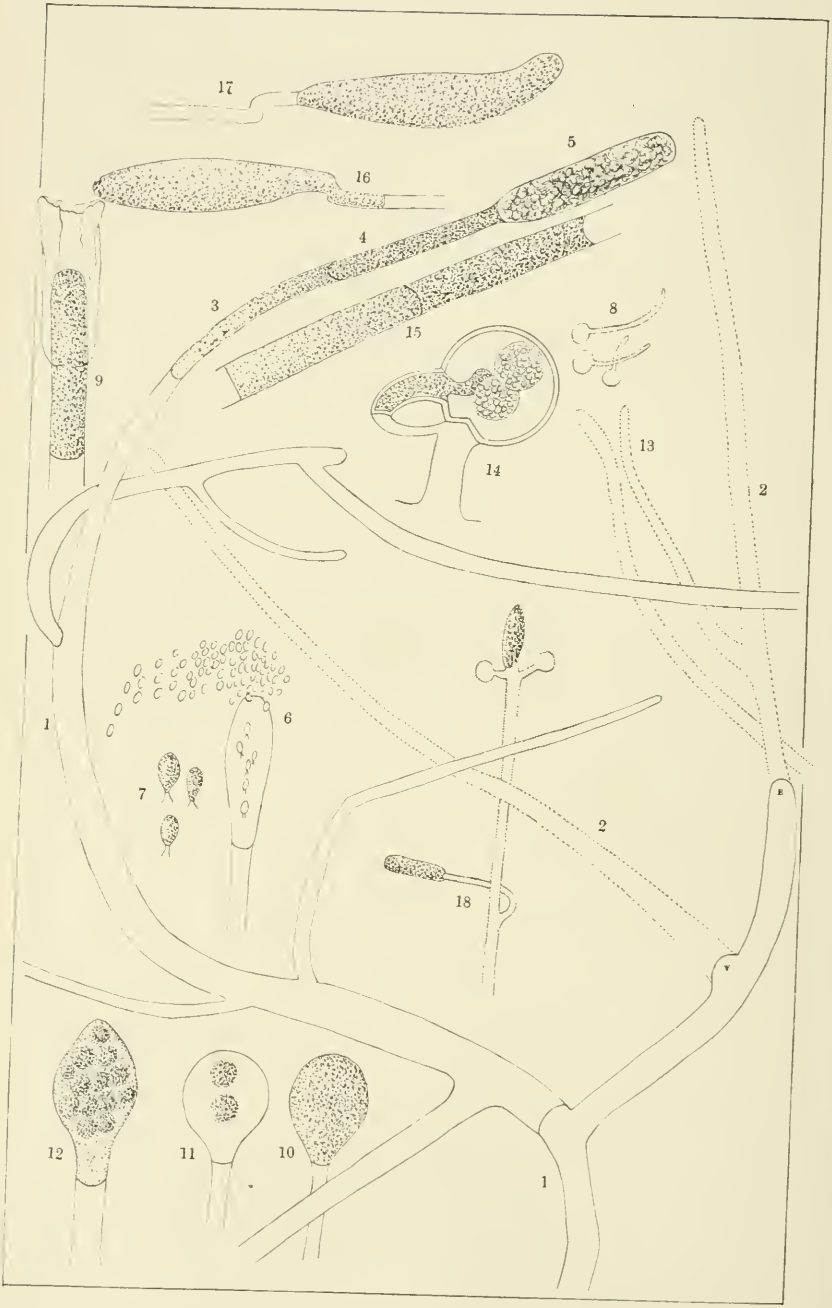
Naturforschende Gesellschaft zu Freiburg, Berichte: Vol. III.—Vol. IV., No. 5 (1888, 1889).

Mémoires de la Société des Naturalistes de Kiew: Vol. X., No. 1 (1889).

Bulletin de la Société des Naturalistes de Moscou: 1888, No. 4; 1889, No. 1.

Sitzungsberichte der konig. böhm. Gesell. der Wissenschaften, Prag: 1889, Part 1.

Memorias de la Sociedad Cientifica "Antonio Alzate": Vol. III., Nos. 1, 2 (July, August, 1889).



LOCKWOOD ON SAPROLEGNIA.

Journal of the New-York Microscopical Society.

Vol. VI. JULY, 1890. No. 3.

FUNGI AFFECTING FISHES—AN AQUARIUM STUDY.

First Paper. Saprolegnia.

BY SAMUEL LOCKWOOD, PH. D.

(*Read March 7th*, 1890.)

Does it not appear like the disciple's being above his master when he rides his hobby at such a technical rate that one even fairly informed cannot keep up with him? But then it seems erudite, and *more Germanico!* Still, I think, the light of science should not be darkness; and the most of us know how easy it

Description of Plate 22.

1, 1, Thallus of *Saprolegnia ferox.* Its peculiar branching induced the drawing. The heavy lines show the old plant; the lighter ones, *2, 2,* the part which grew while under observation.—Time, 55 minutes. The points, *A, B,* of course, disappeared, each in the continuity of its own cylinder.

13, Where the two young hyphæ met and nearly touched but diverged.

3, A cell in which the protoplasm has turned into germ, or spore-plasma, and has begun to granulate. *4,* A cell in which granulation has advanced. *5,* A sporangium, or mother-cell, in which the spores are nearly ripe. *6,* A sporangium from which the zoospores are escaping, as motile, or swarm-spores. In this cell are six spores unable to leave. *7,* Three zoospores greatly enlarged, showing their cilia, and general amœboid condition. *8,* The same, having become spherical and invested in a membraneous shell, and now germinating.

9, A forthcoming sporangium growing through the remains of an empty sporangium, such as may be predicated of cell *4,* when cell *5* is empty.

10, An oogonium in which the protoplasm has become spore-plasma and is granulating.

11, An oogonium whose contents have been taken up in making two oospheres, which are to be the ultimate spores of this *Saprolegnia ferox.*

12, An oogonium full of oospheres, the crowding of which is lengthening the capsule at the top, where the rent will occur for the emission of the spores. These oogonia in the specimens studied were much varied in form, some being almost cylindrical, some globular, the normal form being flask-like.

is to follow the great masters of knowledge. Your reader, who is not a fungologist, without pretending to much that is new, will try to tell in a comprehensible way, the story of what was seen and done in a winter's attention to the sick fishes in his aquaria. Happily, this much can be safely promised: However threatening may be a theme dealing with disease and death among one's pets, our subject shall not be repulsive, though it is true that in such, or kindred pursuits, the inquirer does upon occasion find himself a little tried.

A very pretty thing is one of these microscopic fungi, and in some roles they are the elfins of goodness. But alas they do sometimes appear as sprites of malevolence ; for how often does the student see them in unlovable situations, almost dampening his devotion with disgust, if not tempting to an outburst of mild profanity. He has mounted a precious rarity in a dry cell. It proves a "sell" that is not dry—but serious. There was just enough moisture in that little air-tight chamber to nourish a mischievous stowaway, a concealed fungus spore, and the rarity is enveloped in a shroud of mold. I recall a scene. I was at my summer retreat, and the obliging postmaster at home had forwarded a little box stamped at letter rates. Boniface Pry followed me to my room against my wish. The opened package contained a dead mouse, killed by a fungus. The stench emitted on opening the box was indescribable, driving my host to the outer door, where, pinching his nostrils with thumb and finger, and mistaking my interest for insensibility, he exclaimed: "Can you to-lu-rate that o-di-us smell?" How singular! The man's dialect, especially his peculiar prolongation of the vowels suggested a scientific diagnosis. Yes, that fungus which killed the mouse had been pronounced either a Torula, or an Oidium.

Previous to the above event, Dr. Leidy had exhibited at a meeting of the Philadelphia Academy of the Natural Sciences a mouse caught in the children's department of the Blocksley

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14, An oogonium, showing the antheridium fertilizing the oospheres. After De Bary.

15, A broken hypha, showing two cells with the granulation of the protoplasm well advanced. It was in these cells that the phenomenon of cyclosis was witnessed.

16, 17, Curious abnormal forms of sporangiæ. In *16* the septa is below the elbow, and in *17* it is above.

18, A branched hypha; below is a small incipient sporangium, and at the apex another, with what seems to be an incipient oogonium at each side.

In this plate no attention has been given to the magnification.

Hospital. The ears, nose, and side of the face were covered with a white mold, which had eaten into the flesh. The Doctor thought it resembled the Aphtha, or thrush fungus. He even intimated that the animal might have been eating crumbs dropped by children having the thrush.

The role of these microscopical fungi is universal, in the earth, the waters, and the air. No class of animal or vegetable form is exempt from these minute parasites, and descending to their relatives, the microbes, we reach the propagators of the pestilence in man and beast, as the thrush fungus, *Oidium*, or *Saccharomyces albicans*, which attacks the mucous membrane of the mouth and throat of children. But the fungus which causes the skin disease known as favus, the *Achorion Schoenleinii*, is much like a *Torula*, and is often fatal to rodents, and the distance is not far from this parasitic ærial mold to the parasitic aquatic mold, represented by the *Saprolegniæ*, which beget terrible skin diseases on the cold-blooded animals, newts, frogs, and fishes.

Last October a friend in Trenton, N. J., caught for my aquarium a number of the two species of sunfish, *Enneacanthus simulans*, the spotted sunfish and *Mesogonistius chætodon*, the black-banded sunfish. To await my coming for them they were put in a tub in the yard, supplied with the city water from the Delaware When I called it turned out that many of them were attacked by the fungus, which afterwards proved to be chiefly *Saprolegnia ferox*. I picked out eighteen that seemed to be unaffected. These were introduced into a large aquarium, containing already some fifty fishes of ten species. Alas! it was soon evident that the pestilence had invaded the little community. In three days I could see the mold whitening on some of the Trenton fishes. Another aquarium was arranged at once as a quarantine, into which every infected fish was put as fast as detected. Besides the two sunfishes mentioned, I already had another species in the tank, *Lepomis gibbosus*, the common pumpkin-seed. Curiously the inmates of the hospital were all sunfishes excepting a pirate perch. My treatment was painfully unsuccessful. In about six weeks I had lost twenty-four sunfishes by the fungus. This included all my Trenton fishes, save a solitary one—an adult.[1] I had even at intervals emptied, and

1. Since the above was read to the Society I find that a pirate perch has succumbed to the fungus.

as thoroughly as I could, cleaned out the quarantine hospital. I also had a still smaller aquarium into which I removed from the hospital such as I thought might be convalescing.

It must be that there are constitutional differences in fishes, even of the same species. The one I saved was an adult black-banded sunfish. Supposing it to be cured, I restored it to the large aquarium, and in three days I saw symptoms of a second attack of the malady. The fishes thus suffering would rub themselves by swimming rapidly against a stone. But this could only touch the sides of the animal; thus the head and back would have an unbroken white coating not unlike cotton. I hastily returned the "Bandie" to the hospital, where he soon improved, and was then transferred to the little aquarium, which I called the sanitarium, and was allowed to stay there; thus a complete cure was effected.

So far as my time would permit I submitted specimens of the fungus to the microscope, and was rewarded with some good displays of the methods of growth, and although not altogether original, it will, I hope, not be amiss if in a brief way the life progress of the plant be given.

Reference has been made to the *Aphtha*, or the parasitic fungus of thrush. This is known as a sprouting fungus. The spores arranged in irregular rows, each sprouts at one end, not unlike grains of wheat. Suppose a row of such grains, each one just where it grew, bursting and sprouting, first on one side of the row, then on the other, that is, alternating though irregularly, and we should have a fair picture of the process. But our parasitic *Saprolegnia* proceeds very differently. The motile spores, or zoospores, we will suppose, have swarmed, and escaped, or been emitted from their sporangium, or generative sac. They are now on their travels in the water, for each one has its propelling cilia. Having found a staying place and undergone a change, to be described, either immediately or after due waiting, germination begins. A slight pimple appears on the surface of the spore. It is not a bud or a sprout protending through a dehiscence, as in a seed—but a pushing out of the skin itself, until it is prolonged into a little tube, like the finger of a glove. This tube grows, becoming a mycelium or hypha, really a hollow or tubular thread. Of these thread-tubes or filaments, is the plant

mass or vegetative system of our fungus chiefly composed. The base of each mycelium is rhyzoid, that is, though not in form, it is in function root-like ; for as rootlets these basal ends penetrate the solid tissues, and suck or extract the nitrogenous nutriment. We may call the outer parts the fronds or branches, as they are the fruit-bearers, the spore capsules, of which our *Saprolegnia* has two kinds on the same plant. One of these, borne at the end of the hypha, is club-shaped, or with its hollow support looking in the microscope exactly like a miniature bullrush. This is called a sporangium, and its contained seed-like bodies are known as motile spores, or zoospores, because of certain animal-like movements.

There is another kind of capsule, usually terminating a short hypha. It is usually flask-shaped, though sometimes globular. This is known as an oogonium, literally, egg-bearer. Its contained round bodies are called oospheres, or egg-spheres. They are much larger than the zoospores, and these quasi animal appellations are given them because they have to be fertilized, unlike the seedlets in the sporangium, already noticed as zoospores, or motile spores. In a word these tiny oospheres have a similar necessity to the ovule in a flower, which owes its life force to the pollen from the anther. So to meet this need in our fungus capsule a bud is seen to grow from the pedicle or neck of the oogonium, that is, the capsule containing the spores. This curious organ grows rapidly, and is developed simply in the nick of time; that is, when the oospheres are just on the eve of maturity. At first it is merely a little tube, just long enough for its tip to reach the flask-like capsule above it. Now a change rapidly occurs. A septa or dividing plate grows in the tube, thus making the upper end a cell. This is filled with protoplasm, which now separated from the protoplasm below the septa, is affected by some special action of organic chemistry, and becomes a little opaque, and changes into a substance known as gonoplasm. It is now charged with a communicable life essence. At this point of time, from the centre of the disc made by the tip of the cell flattened against the outer wall of the capsule, the tube in a much smaller diameter, thus having a shoulder around it, is lengthened, penetrating the oogonium at a weak spot until the tip of this tube so lengthened reaches the nearest one of the con-

tained oospheres. It gently touches this little spherical mass of naked protoplasm, the nucleus of which coalesces with the imported gonoplasm. The oosphere now takes on a covering, and thus becomes a cell, and is endowed with a peculiar life force, and is recognized as an oospore. It is complete, and for its own species, the ultimate or highest possible productive spore. As such, though perhaps indefinite, it has an advantage over the zoospore, and with this superiority it starts on its own career. As to that little fertilizing organism, because of its likeness in function to that of the anther in a flower, it is called an antheridium.

One must feel assured that this complexity of mechanism is not a superfluity of nature. In the long run this organic interrelation is indispensable to the continuance of the species in its normal integrity, yet these lowly plants are possessed of a marvelous plasticity of accommodation to the situation of circumstance. The *Saprolegnia* can be a saprophyte, that is, a dweller on some inorganic thing, a stick or a stone. But it only revels in its life role as a parasite, its host being a living thing. So for a while there seems at times an arrest, or break in the process of development. The symbiosis of the brood-sac is dispensed with, and the simple sporangium capsule with its motile spores is made to suffice. The play of life is for the occasion gone through, with the prince left out, or perhaps the metaphor is more apposite, the establishment while awaiting developments is content to graduate sophomores.

A fungus, as we are now considering it, is a vegetative body without stem or leaf, and such a body, not reckoning the parts necessary for fructification, is called a thallus. This is composed of cylindrical threads or filaments which sometimes branch. They are really tubular membranes filled with protoplasm, and growing or lengthening at the apical end. Each thread may be called a hypha, while a mycelium may consist of one or more hyphæ. As the hypha lengthens septate divisions occur in the tube, thus separating it into cylindrical cells ; and these may become spore-sacs, the top one developing first.

The saprolegnia mold is usually a floccus of straight threads, standing out like hair. Noticing in some fungus just taken

from a dying fish, that the mycelia were very much branched, I undertook to draw a plant as seen under the microscope. Truly I was entertained with an interesting sight. I got badly bothered on my drawing, being somehow unable to keep the parts in their relative proportion. It was as if an artist, after outlining a face, should find the nose lengthening to elephantine dimensions. The truth was, I was attempting to draw some mature hyphæ, unconscious of the fact that young hyphæ were growing under my eyes. Of course, while the older parts of the plant remained stationary, the young parts kept advancing in the field because they were growing, thus lengthening. My first assurance of this was that a spur or bud-like projection from a hypha which I had drawn had begun lengthening, and had become a young hypha itself. I at once noted the time my observations extended through, fifty-four minutes by the watch. It is like witnessing the work of a mysterious hidden hand, when one follows this steady growth. How noiselessly the hyaline cylindrical thread, with its membraneous wall of cellulose lengthens! And how is it done? All the time it is full of that subtle life-stuff, protoplasm. Now I see it swelling out at one spot like a bud; this elongates, and in fact branches. It is also noticeable that here and there a septum forms dividing the cylinder into sections or cells. The contents of these cells become increasingly opaque; for the molecules of the invisible protoplasm are now aggregating into visible granules. This differentiation is the most advanced in the apical or top-most cell, for here the granules are further aggregated into roundish masses of granules. These when ripe will be the sporules, or zoospores. The cylindrical cell which now contains them is their sporangium. And here two facts are observable: the enlarging of these immature sporules produces a crowded situation, so that for a while their form is affected from squeezing. They are a little polygonal instead of spherical, and the other interesting fact is that the cell must expand under this internal pressure; hence we have in form the head of a bullrush. A moment comes when under this internal pressure there is produced a crack or slit at the tip. With the inlet of pure water and free oxygen, there comes a sudden and final expansion of the sporules, and a resulting escape at the apex of the sporangium.

It was a very interesting sight when I saw for the first time this emission of the sporidia from the sporangium or mother-cell. All kinds of similitudes came to mind, from that of bees swarming, to the letting out of an unruly rural school. Like the latter, it was a quasi jail delivery. It is a real liberation of the sporules. The disquietude begins at the back seats, or dropping figures at the bottom of the capsule, or sporangium. The commotion thence ascends until those at top are affected, when at the small opening these motile spores rush out in a swarm and sail dispersedly away. I noticed a few, maybe six, remaining in the evacuated capsule. They seemed uneasy. The opening at the top of the sporangium had closed. Though showing movement, they had lost the momentarily given impulse which enabled the others to squeeze through, and "get out." It was the old adage of "time and tide" over again, for they were "kep' in."

Here I will quote Hines' description : "Just before escaping the zoospores at the base always take on an oscillating motion, which passes to the zoospores next above, and so on to the summit, causing such a pressure that in less than a minute the power is such as to cause a rupturing of the sporangium, which in normal conditions always takes place at the summit. The zoospores now pass out at first very rapidly, so that it is impossible to count them, but when about one-half out they become more quiet, seldom losing their motion, however, until all have passed from the sac. In passing out they are very much constricted, so that if any lose their power of motion before they have escaped, it is impossible for them to pass out. Having passed from the sporangium, which was emptied in one minute, they swarmed around very lively for nearly four minutes, at the end of which time they settled down, lost their cilia, and became spherical. At the end of one hour and thirty minutes, they had germinated."

The process of liberating the spores in this species of *Saprolegnia* is much simpler than in those species known as *Achyla*. In these the emitted spores gather at the tip of the sporangium, or place of emission, in a globular cluster-swarm. They are seemingly naked bodies held together by their own cohesion ; but now each spore is suddenly invested with a mem-

brane, which very soon dehisces, and out of this spherical cell comes its occupant, somewhat bean-shaped or pseudo-crescent, if you like, with two cilia by which he sails away, a bashaw of two tails, leaving his jacket behind him.

De Bary, says: "The distinguishing mark of the *Saprolegnia* is that the spores are in the motile state as they issue from the sporangium, and that the branch of the thallus which bears the sporangium grows through it when it has discharged its spores." The walls of the emptied sporangium have become much thinned through absorption by the sporidia, so that the cylindrical section below, which is to become a sporangium, grows through this emptied capsule, becoming in its place the apical cell. The sporules thus emitted are at once motile spores, zoospores, or quasi-vitalized seeds, ready to germinate after a little change. It is like taking a shortened course, in which the symbiosis in Nature is dispensed with for the nonce and, strictly speaking, this is nowhere so anomalous as in these very fungi, where the laws of fructification are peculiarly complex. The common grape vine fungus now so destructive, passes in its development through eight stages or forms of spore, ere the ultimate spore form is reached.

We have seen that the motile spore or zoospore of the sporangium plays much the simpler role. Yet even this spore is subject to curious changes. In the *Saprolegnia* it emerges in an ovoid form, with a pair of cilia. It is then little more than an amœboid. It is not a cell proper. But this may need a word.

No one has seen the film which holds the contents of the dewdrop. This is left to conception. An amœba is the simplest form of animal life—a speck of sarcode, tissueless, a structureless living animal substance. Now when we see it pushing out pseudopodia and retracting them, we must conceive a peripheral or containing layer or film of the protoplasm or sarcode; so is it with our motile ovoid sporule when it leaves the mother-cell, the sporangium. Its cilia are simply projected tubes of the peripheral film. With these it can turn upon itself and propel itself also. Its travelling soon ends, when it comes to rest, and its cilia are withdrawn, in fact absorbed. Very soon this ovoid amœboid spore becomes spherical, and is invested

with a cellulose membrane—in fact it has become a globular cell. If now excused further change it pushes out a tubule, which elongates by growth. This is its germination, and this tubule becomes a hypha, the beginning of a new thallus or plant.

We said if excused further development ; for in some, even at this stage of being, a spherical cell, it is denied the privilege of germinating. The cell will crack open, the protoplasm emerge, a lentil form be taken on ; in a word, it becomes a swarm-spore a second time ere it becomes a germinating spore.

This may be seen in Fig. 1, plate 23. Here the spores are invested with a membrane ; they are cells of granular protoplasm. But they are bursting through the sides of the mother-cell, instead of at the tip, and curiously they leave their shells behind them—actually entering their aquatic world in an amœboid condition. This seemingly anomalous thing is a *Dictyuchus*, another genus of these *Saprolegniæ*. A curious feature in this sporangium is the pressure of subsidiary mother-cells, for it is cut up into small sections.

With the exception of the species just described I think all were the common *Saprolegnia ferox*. But the eccentricities or diversities of growth were many and striking.

I found myself greatly interested in a peculiar exhibition of the phenomenon of cyclosis, or circulation in these filament cells of *Saprolegnia*. In the early stages of the granulating of the protoplasm in a cell destined to be a sporangium, I observed the circulation, or movement of the particles of the granulating protoplasm. The movement was very lively, but not that stately

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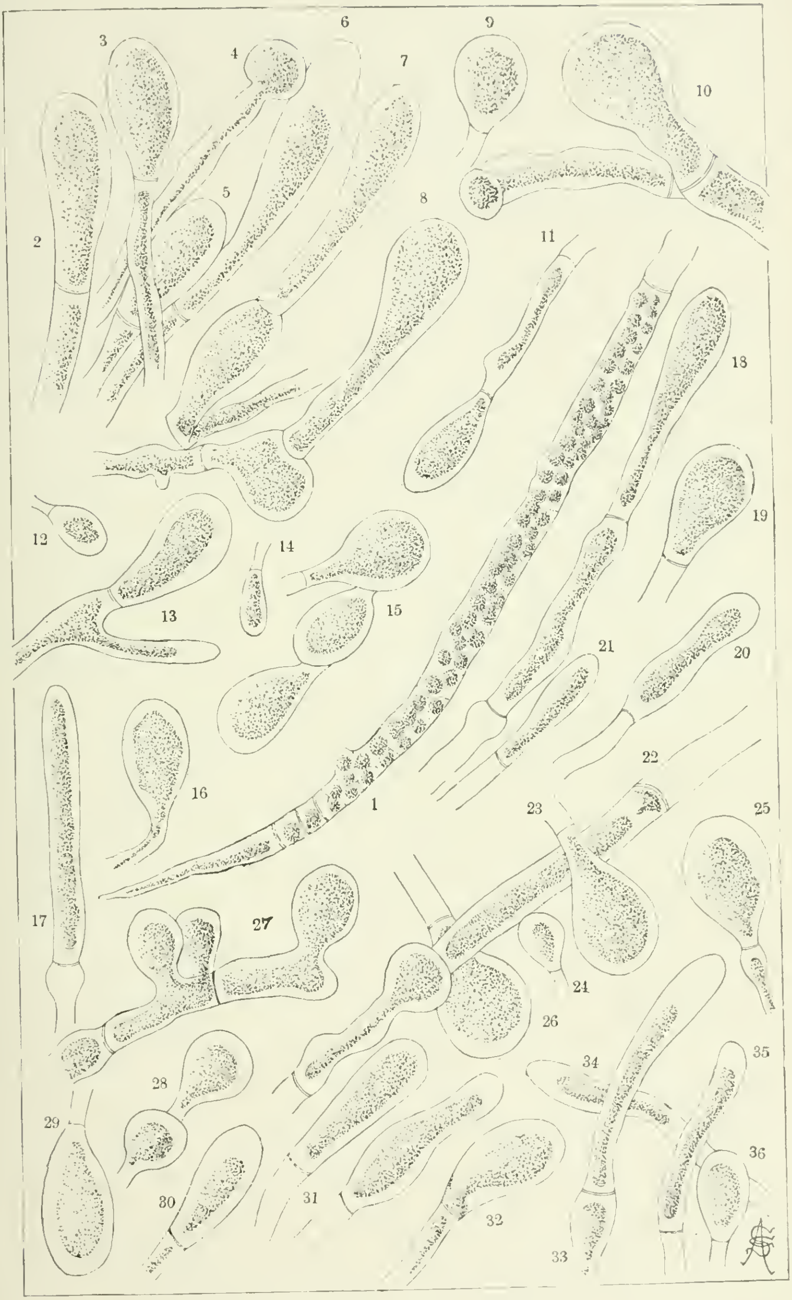
Description of Plate 23.

1, A compound sporangium of *Dictyuchus* one of the *Saprolegniæ*. One of the spores is breaking through the side, which is the only way to gain emission, for there are several septæ, making approach to the apex impossible, nor is the apex of a suitable form for such a mode of escape. It was evident in the original, and is indicated in the drawing, that the swarm-spores were already invested each with a shell, which it left behind in the mother-cell or capsule, and entered the swarm state in an amœboid condition.

The figures in this plate were drawn from specimens mounted in glycerine, and the effect has been to contract the protoplasm, thus making it leave the cell walls. The object of the drawing is to show the variability, even eccentricity of forms, and the figures are numbered simply for convenience of reference. The magnification is about 500 diameters.



LOCKWOOD ON DICTYUCHUS.

and almost rhythmic flow or streaming which one sees in *Nitella* and *Vallisneria.* It seemed to me more like the purposeless impulse of the motes in the sunbeam. The scene was very pretty; for though seemingly crowded I could not detect any jostling in the mazy movement, which would hardly be compatible with the fact that these were naked bodies. There was a glitter, too, which indicated a variation of surface and an individual movement like turning on an axis.

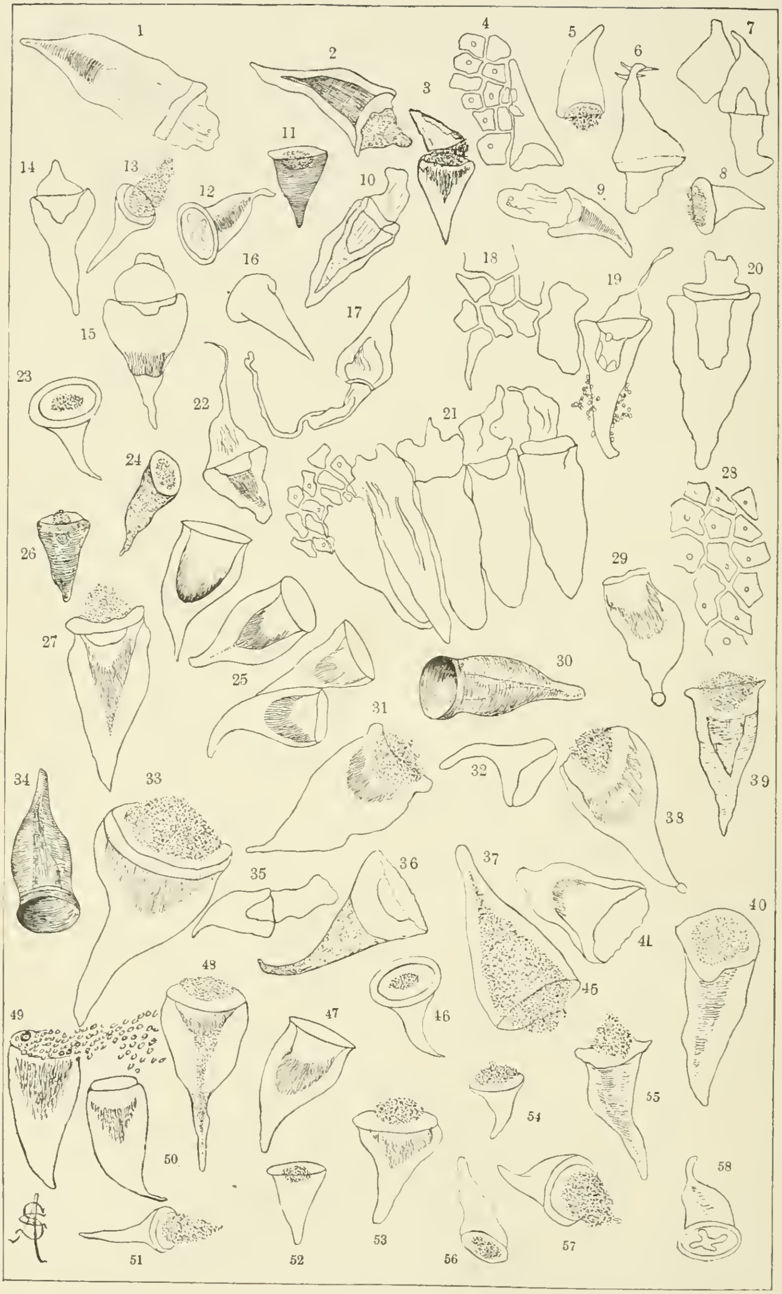
But in respect of motion in these lowly plants there is a sensitiveness which is strikingly like instinct. As the several hyphæ grew under my eye two proceeded side by side, coming at their extremities nearer and nearer. At last I thought they must collide; so, to be in at the catastrophe I watched them intently. But the little things seemed to know their interests better. They came so closely that I could only just see the space between them, when, as if each regarded the contiguity of the other as undesirable, without even touching, each at the same instant started for itself a growth in a diverging curve, and thus they separated, as if upon a mutual understanding. It certainly did look like an amicable compact to get out of each other's way quietly.

Should it now be asked, have we not a fungicide? My answer is not favorable. As regards aquarium fishes I have heard suggested the bathing them in a solution of carbolic acid. But this is impracticable. The solution must be weak, it must not be allowed to touch the gills, and the application must be rapidly done. I remember the late Dr. Henry J. Rice, who in the biological laboratory over Fulton Market had under his care some valuable Japanese goldfishes thus diseased. He expressed himself to me in favor of this treatment, though in his own trials it had failed to save the fish, which must succumb if the acid is applied strong enough to kill the fungus. Let us call it what we will—vitality, constitution, or what not—there is in individuals of the same species differences of power to resist disease. Could an eagle unduly divert muscle making into wing growth, it would become one of the very weakest of birds. This very increase of pinion thus obtained would mean decrease of power; so is it with these Japanese fishes. The muscles have gone largely into fins. Their owner is a coddled, weakly thing. Let disease attack, it is without repellant or sustaining power. Now

it is very different with this same species in its normal state. Among the fishes which occupied my attention this past winter were two of these Crucian carps or gold-fishes, *Carassius auratus*. One of them was the true golden, and the other the pale or silver variety. Neither of these were affected by the fungus, although about a year previous the pale one had a very severe attack of the *Saprolegnia*. I saved it by temporary isolation from the rest.

It must be, I think, that the oospores have in some instances long rests, so that they appear at intervals, even as epidemics; as for example, the *Achyla*, that formidable species of the saprolegnia group, which sometimes so greatly injures the salmon. What may be the sufferings of these cold-blooded creatures when succumbing to this scourge, one cannot say. To me it has appeared to be considerable. Truly pitiable is the sight of one of these pretty creatures when in the throes of death from an attack of this fungus disease. Each fin is now collapsed like a closed fan whose folds are held in the meshes of an agglutinated web. From tail to nose it is invested with a white, gnawing, morbific shroud, with here and there a rent, disclosing a purple-red patch of scald beneath. At last this fatal flocculence has reached the respiratory functions, and the crimson gills grow livid, surcharged with the unaërated blood, and the erst rapid breather now gasps at intervals in spasmodic agony, and in a spasm expires. The jet optic set in a ring of gold seems to look at me with some dumb utterance, as if asking the unanswerable wherefore? And there comes that esoteric whisper through the ages—the whole creation groaneth, waiting for the manifestation.

Occupants of the aquarium: *Enneacanthus simulans*, spotted sun-fish. *Mesogonistius chætodon*, black-banded sun-fish. *Lepomis gibbosus*, common sun-fish or pumpkin seed. *Carassius auratus*, crucian carp, both the gold and the silver varieties. *Melanura pygmæa*, Eastern mud-fish. *Amiurus catus*, horn pout, small catfish. *Erimyzon susetta*, chub sucker, mullet. *Aphododerus sayanus*, pirate perch. *Catostomus communis*, white sucker. *Hybognathus argyritis*, silvery minnow. *Notemigonus chrysoleucus*, shiner. Tadpoles or larval frogs.



LOCKWOOD ON DEVŒA.

FUNGI AFFECTING FISHES.—AN AQUARIUM STUDY.

SECOND PAPER. DEVŒA.

BY SAMUEL LOCKWOOD, PH. D.

(*Read March* 21*st*, 1890.)

In July, 1867, appeared in the *American Naturalist* a paper on "The Sea Horse and its Young." The article gave my observations of a male Sea Horse, *Hippocampus heptagonus* Rafinesque. The almost eccentric habits of this grotesque little marine fish induced a strong desire for other living specimens in order to learn more about it. In the fall of 1884, after seventeen years of waiting, I obtained a fine female. It proved very interesting, but died in February of the ensuing year. In 1887, the *American Naturalist* contained my second paper on this fish under the title: "More About the Sea Horse," from

Description of Plate 24.

The figures of this plate show that while the funnel pattern prevails in *Devœa* the range in variation of the type is great.

Figs. ***1, 6, 7, 9, 10, 14, 15, 17, 19, 20, 21, 22, 35*** show this sporangiform plant or thallus, with its cap or operculum. The extremes of form of the cap appear in ***14*** and ***17***.

2, 5, 8, 12, 27, 31, 33, 45, 51, 57, swarm-spores at different stages.

3, A spore-swarm lifting off the cover of the sporangium.

49, A spore-swarm leaving the mother-cell. These are enlarged much beyond the scale of the other figures. To the left is a very large spore, suggestive of an oospore !

21, A patch of thalli, of abnormal forms. To the left of ***21,*** also in ***4, 18*** and ***28,*** are epitheloidal looking bodies, which I think are the faces of these sporangoid thalli distorted by pressure, or growth crowding.

25, 47, Show five emptied sporangia, with sharp rims, and symmetrical forms.

30, 34, Empty sporangia. The contents seem denser, hence the deeper shading. This feature is seen also in ***11, 24, 26, 39,*** and in a less degree in others.

19, Adherent spores. Too large for zoospores.

6, These doubtful mycelia show the only instance of even a dubious appearance of rootlets.

The variations of form at the aperture are interesting. Figs. ***23*** and ***46*** show a wide, flattish top of sporangium with small aperture. ***26, 48, 51,*** with conical surrounding of aperture. ***30, 34,*** neck of aperture cylindrical. ***50,*** abruptly shouldered. ***25, 47,*** lip of aperture thin, or sharp, and excurvate. ***3, 5, 54,*** incurvate lip of aperture, the typical form.

12, 58, Each with a quadrifid aperture. A very eccentric form. The figures are magnified from 700 to 900 diameters.

which let us make a short extract. Having spoken of an "intense sympathy" with the little creature, this is added:

"Alas, there was now too much ground for sympathy,—a terrible malady had begun to take hold of the poor thing. The face took on a comical aspect. On each side rose a swelling as if she had the mumps. With a hand-lens I found that these were blisters, white vesicles, and so buoyant as to annoy her by producing eccentric movements. I contrived to pierce them with a needle, and so to let out the confined gas. This gave immediate relief. But they came again, and by and by my surgery did not avail. They increased, and the buoyancy would raise it to the surface, and the little sufferer despite all help would float. And so it was on the last day of February at an early hour I found poor Hippie afloat on her beam ends and dead. I had her alive just four months."

I was much surprised at this appearance of a severe skin disease, which extended over the entire body. It seemed to me a malignant scurvy. The strange thing was the presence of those white vesicles, or blisters, which actually raised it so high that it would float on its side at the surface, making it impossible for the fish to sink. A puncture of each blister with a needle would relieve the sufferer, which at once would descend in the water. The error into which I fell is now apparent. I supposed that the fish was ailing from an internal source, such as a blood disease. I am now certain that had I used the microscope upon a scraping from the skin, the cause would have proved to be external, in fact, parasites, as with my fishes in the fresh water aquarium. But in their case the fungus could be seen as a flocculent mold. The matter on this Hippocampus could not be divined by the unaided eye. At its death, I observed that under each vesicle was a spot of effused, or extravasated blood, and so the hypothesis was docketed in memory of a scorbutic affection.

In the autumn of 1889, I was the fortunate possessor of four living female Sea Horses; I was resolved to do my very utmost to make life possible and pleasant for my new pets. But these quaint creatures are to the utmost dainty and particular. One cannot feed them as he does other fishes. Their tubular mouths take in the invisible organisms of the water; in a word their food is microscopic. So for their sole occupancy, I started three small

marine aquaria—oxydizing the water with the two algæ, the green sea lettuce, *Ulva latissima* and the red coral like *Gracilaria multipartita.* Soon the infusoria appeared, and soon after came fine crops of diatoms. My plan was to put the four fishes into one of these small aquaria, allowing them possession until I supposed their food was reduced; then I transferred them to another, and in time to the third, after which they went back to No. 1. By this routine or interchange their supply of food was sustained, the water being kept well stocked with microscopic life.

In about four months, I made what seemed to me an interesting observation. It was the fact that these little creatures had the faculty of mimicry. In respect of color, their normal hue was that of a slaty or yellowish grey. From this they could take on two extremes, becoming either almost black, or even an ashy white. This latter fact led to a deception, for noticing in one of the Hippocampi certain white spots of rather long continuance, I misinterpreted the fact—as partial, or deceptive mimicry. At length I beheld to my dismay, a white blister, with some indications of uneasiness by the fish. It recalled the experience of two years before. The vesicle was at once pricked with a needle—but the malady spread over the body, when it soon died.

As I was then in the midst of my study of *Saprolegnia*, I lost no time in getting an almost invisible scraping of the skin under the microscope, when lo! my scorbutic hypothesis "went up" leaving me with another fungus of a singular character on my hands. In size the new plant compared with the *Saprolegnia* was as the little fern to the sturdy pine under whose shade it has grown.

I found some difficulty in the study of this object due to its extreme minuteness, and the crystalizing of the salt in the seawater which would proceed in each mount, thus burying or breaking up the plant. It became necessary to wash away the salt, to the cruel cost of a sad waste of material, and a pitiful destruction of the natural grouping. With these disadvantages, after a number of trials some success was achieved in eliminating the salt, and some fair mounts were made in carbolated glycerine.

In a few days another fish died, and in about three weeks all

were dead. I was hampered with the smallness of the specimens, and the extreme limitation of material, and the fact that I did not succeed in getting a growing slide. As to the size and transparency of these fungi, it was observable that though the fish for a while before and after death were ashen white wherever the fungus had attacked, yet upon being dried, the natural dark color of the skin returned, and the fungus seemed to have gone off in the air.

Mounted specimens were sent to several eminent fungologists, two of whom, to my surprise, ventured the guess that they were allied to the *Saprolegniæ*. This surmise could only come from the fact of similarity of habitat. A mount was sent to the distinguished specialist, Dr. M. C. Cooke, who wrote that he failed to find the specimen on the slide ; which was to me quite a disappointment.

Speaking generally these minute plants are funnel-formed, though the short quasi-stem ends in an imperforate point. Hence a friend on viewing them in the microscope called them little cornucopias. But these tiny wine-glasses with no bottoms or supports, how are they to stand up ? A funnel or cornucopia could be made to stand erect, if the bottom were stuck in the ground. It really seems that it is the way this fungus secures attachment by the imperforate point or end penetrating the epidermis of the fish. As these are so close together their upper parts, when a patch is put in the microscope, present the appearance of a plane of scales, instead of the cottony flocci of the *Saprolegniæ;* sometimes these little cups are so crowded or squeezed that instead of presenting to the eye looking down the instrument upon them a plane of circles, they have the aspect of polygonals.

As to the fungus attaching itself by the point of its short stem, the little bend or curve sometimes suggestive of a hook, might perhaps, from the vast numbers in a series, serve as a multiple holdfast. But the usual economy of a fungus is an apparatus of rootlets or rhizoid mycelia. As I have been unable to detect such a holdfast may not its cup-like thallus suggest hair-like surroundings of the pointed base of the plant, each rhizoidal hair with a cup-like ending or sucker, not unlike the attachment of *Empusa muscæ*, the fly fungus on the window pane; for though

De Bary has relegated it "to the history of errors," the notion is not extinct that the aërial mold *Empusa* is but a condition of the aquatic mold *Saprolegnia*.

This cup-like plant is surmounted by a lid or operculum, very suggestive of that to the capsule of a moss. It lacks the symmetry of the latter—being sometimes a relatively short cone, and at other times quite long. The rim or edge of the cup is inflected, so that the aperture into which the lid fits is not nearly so wide as the diameter at the face. Over this opening sits the operculum, thus giving the appearance of two funnels, with their apertures facing each other, the smaller one being uppermost.

The above is the position until fructification is complete, when the sporidia become a heap, rising into the operculum or cap, and lifting it up and off. They are now a spore-swarm, and as such are quite large when compared with the size of the parent thallus, but individually they are so small that a magnification of about 900 diameters gave only limited details of structure.

It thus appears that the thallus, or entire plant is a mother-cell or capsule; in fact I believe it is a compound sporangium. I have seen numbers of these emptied capsules open or split down one side, from the aperture. These seeming rents revealed lines irregularly parallel, and lengthwise of the sporangial capsule. These are each attached by one edge to the inner wall of the capsule like the gills in the pileus of a mushroom, or any agaricoid fungus. These laminæ do not reach across the capsule; thus they form a well-like space under the opening or outlet which is covered by the cap or operculum. It seems to me that the spaces between these laminæ serve for sporific or quasi-hymeneal planes, from which the sporidia are discharged into the central part, or well of the sporangial capsule, and thence like a little cloud they swarm as zoospores at the outlet, that is, over the edge of the cup-like mother-cell.

As noted in our first paper a distinguishing trait of the *Saprolegniæ*, is the issuance from the sporangium of the zoospores, or motile spores. It seems to me that these swarms of this marine fungus must consist of motile sporidia. But on two points we need light—the history of the spore development or complete fruition —and assured knowledge in respect to the absence or presence of

the rootlets or rhizoid mycelia. On this point it may be remarked, that the necessity for these rootlets is not the same in the Hippocampi, and the percoid fishes. In these latter the scales are very thin plates, lapping upon each other shingle-wise, hence, easy for the mycelia to creep under. But the scales of the sea-horse are not unlike those of the sturgeon—rising to a point at the middle like the boss in a shield. They do not lap on one another, but so to speak, are soldered to the epidermis. Hence, there are spaces of naked skin between these plates, and on them the fungus finds place for attachment.

I think then of this marine fungus, enough has been observed to afford marks for differentiation, and determination from all others. Thus I will attempt a definition of this new genus, and new species. Its habitat on fishes, at once suggests the *Saprolegniæ* as its family relation. A striking *difference* appears in the form of the thallus. The entire plant seems to be a cup-like, or funnel-shaped capsule, with a hood, or cap-like operculum ; and the impossibility to differentiate the thallus or plant into hyphæ and mycelia.

But functional features are more important than morphological, or perhaps it is better to say—in respect of our plant, its physiology is more significant than its anatomy. And in this view I find marked family traits or *resemblances.*

1. The spores are endogenous, being produced in a mother-cell, or sporangium with no other organic impact.

2. These spores when ripe attain for a short time, a few seconds at most, a self-assertive force, when by individual and collective enlargement or swelling, they raise and push or lift off the hood which caps the sporangium.

3. These sporidia are self-moving bodies, and their motile force is not derived from any immediate communicative impact or descent. Hence with reference to this mysterious vitality they are well called zoospores, while with regard to their rushing movements at the instant of escape from the sporangium, they are called motile or swarm-spores.

4. At this stage these motile spores are hardly worthy the name of cells. If there is at all an outer and inclosing membrane no lens has shown it, hence it can be no more I think than the film of the dew-drop. Their appearance is that of

irregular roundish masses of cohesive granuloid protoplasm. Some vacuoles seem discernible, but beyond this my $\frac{1}{12}$ water immersion with B eye-piece failed to go, not even revealing the usual propelling ciliæ. Yet we must suppose the existence of the latter, with also the central neucleus, imbued with that force necessary to the coming phenomena of life.

5. If we add that in common with the *Saprolegniæ* their home is aquatic, their habitat as parasites is the fish, and their mission to weave like Dejanira a toxic shroud of suffering and death upon the living, the resemblance to *Saprolegnia* is in some particulars quite striking.

I feel that without the special knowledge of the fungologist, and the algologist, it becomes one to be modest in the matter of speculation. Yet it may not be presumptuous in this connection to say that our new fungus has impressed me with the conviction that the believers in a border land for these aquatic molds between the fungi and the algæ may not be visionary after all.

Regarding our fungus as a novelty, it should be christened in due form, for before it can go into scientific registration, it must receive a canonical description.

Thallus, an infundibuloid capsule, or sporangial cell, the basal end, an imperforate point, often a little curved, constricted or inflected at the rim, making the aperture about $\frac{4}{5}$ that of the diameter across the face. Fitting to this a membraneous cap or operculum, very variable in length, and form of the posterior part. Inside the capsule a hollow-core of somewhat wavy or irregular parallel planes, their inner edges making a well in the middle of the capsule. The sporidiá from these hymeneal lamellæ issuing into the well, there swelling, the mass rising lifts off the operculate lid, flows over the rim, and thus swarms from the mother-cell. Neither hypha nor mycelium observed. History of the spore development unknown. Habitat-Parasitic on the marine fish, *Hippocampus heptagonus* Rafin.

As esteeming the scientific zeal of a member of our society, the species is named, *Devæa infundibilis* Lockwood.

Note.—Prof. Bashford Dean suggests the question: "How much may any injury to a fish, such as removes the external mucus, have to do with its susceptibility to the fungus?" As perhaps bearing on this let me mention that the egg of a Nereid must have been in the water when I improvised my little aquarium for the Hippies. It attained a growth of three inches in length, and was not hurt by the fungus. The Nereids are smooth, and burrow in the sand, and their many joints or sections afford easy places for the fungus to attach themselves.

INAUGURAL ADDRESS OF THE PRESIDENT,

P. H. DUDLEY, C. E.

(*Delivered January 17th*, 1890.)

In the selection of your presiding officer, I am deeply sensible of the honor conferred, and not unmindful of the responsibilities implied. The Society has now entered upon the thirteenth year of its corporate existence, showing even in this busy city, the commercial metropolis of the country, that there is a necessity and demand for such a society as this. By its support and constant growth the wisdom of its incorporators has been shown. As members of the Society it is not only our duty, but also our pleasure, to take up the work they so well began and carry it on with a will, so that the society interests may be duly enhanced

The evidences of material prosperity are before you.

1. Ten fine microscope stands.

2. A cabinet of slides containing many valuable and rare specimens.

3. A library containing the current publications of interest to the Society.

4. And last, but not least, the publication of a Quarterly Journal of the proceedings of the Society, which goes to all parts of the civilized world. This last feature I believe is not enjoyed by any similar society in the United States. These are substantial facts in which each one can take a just pride and feel honored by being a member.

The building up and maintaining the work of the Society cannot be best done by a few individuals, no matter how important their contributions may be, but by the combined work of all its individual members. It is not necessary, nor is it expected, that all devote their energies to the same branch ; but that each work in that which is of special interest to him. One of the important advantages of the Society is that members can bring their special work before a body where it will be appreciated, and in return receive that sympathetic stimulus which encourages them to greater efforts. On the other hand, members who are not working in that special field gather in a few mo-

ments the results which have taken perhaps weeks and months to ascertain. The workers and hearers are mutually benefited.

Whether the microscope is used as an instrument purely for scientific research, or for seeing the beauties of organized structures, it develops and broadens the conception of the mind, aiding one to understand and take advantage of many of the laws which control matter. As stated in the admirable address of our retiring President at the last meeting, the French savant, Louis Pasteur, by his studies on Fermentation with the microscope, ascertained the laws which governed it. He found that it was due to the growth of definite organisms in every case, and not due to spontaneous generation. Knowing the laws of the growth of those organisms, he could produce fermentation, or check it at his pleasure. This simple truth which remained hidden for centuries is one of the grandest yet revealed by the microscope. Its discovery at once led to the use of antiseptic measures in surgery, and thousands of lives have been saved thereby. Koch soon took up the principle, enlarged its application, and discovered the bacillus of Asiatic Cholera, thus materially reducing the dread of that disease. The laws of the growth of this microbe are now so well known that the spread of the disease can be easily checked and stamped out.

The use of the microscope in studying the sources of contamination in the water supplies of our large cities is hardly less important. In nearly every department of applied science the microscope forms one of the necessary instruments of research, and its use is being daily extended. The use of the microscope in the mechanical arts, as an instrument of precision to determine definite lengths and sizes, and the ability to duplicate them in quantities, is an application so important that it will soon exert a reflex influence in the improvement of the microscope itself. The mention of only a few of the important uses of the microscope is alone sufficient to show its great value to mankind, and that it is highly creditable to foster its use and disseminate the truths gained thereby.

In taking up the duties of the position, I invite, and feel confident that I shall receive, the earnest and hearty co-operation of the officers and individual members in furthering the interests of the Society.

NOTES ON STAINING SECTIONS MADE BY THE PARAFFIN-PROCESS ENCLOSED IN A FILM OF COLLODION.

[Abstract and translation from an article by Prof. H. Strasser, in *Zeitschrift für wissenschaftliche Mikroscopie*, vi., 150 (1889).]

BY LUDWIG RIEDERER.

(*Read April* 18*th*, 1890.)

Having reported, at the meeting of this Society, held December 6th, 1889 (see JOURNAL, vi., 56), 1st, on enclosing sections in a film of collodion, and 2d, on placing them on provisory supports, I desire now to give an abstract, 3d, on the method of the subsequent staining of such sections, in case the object has not been stained before. As this treatment permits the use of different staining fluids on the same series of sections, its value is obvious.

The successive steps of this method of staining are as follows:—

a. Fixing the paraffin-embedded sections in collodion.

b. Hardening the collodion to a film by turpentine.

c. Removing the film to aqueous or aqueous-alcoholic solutions.

d. Bringing it back to turpentine.

e. Enclosing the sections on provisory supports for preserving, or for mounting on slides.

a. As a support for the collodion-film containing the sections during the whole time that the treatment lasts, no more paraffined or waxed paper is used, but gummed paper.

Thin, well-sized paper, of smooth surface, is caused to receive on one side a coat of a thick solution of gum-arabic in water, containing 10 per cent. (by volume) of glycerine. A mucilage of this composition will dry completely, and the film produced will have no cracks and will be flexible. On this support the sections are secured in collodion, as stated in the first paper, by the use of a solution of collodion, No. 1, containing two parts of collodion and one part of castor-oil, and covered by solution, No. 2, containing equal parts of collodion and castor-oil. It is necessary, however, to give a supporting plane to the collodion-film, on which it will remain stretched, as if on a drawing-board,

during all the following processes. This prevents all rolling or folding, as well as the shrivelling of the film, when coming successively in contact with liquids of different specific gravity and of different chemical qualities. To smooth a folded or rolled film is sometimes very tedious, but to remove wrinkles, caused by shrivelling, is impossible.

Whenever the film of gum-arabic comes in contact with water, it is dissolved, and the paper support and the film of collodion are separated. This premature separation can be prevented in different ways. One way is to leave outside of the space intended for the sections a margin free from mucilage. If the solution of collodion is brushed over this ungummed paper, the collodion will soak the paper and stick fast to it. Another way is to fasten and cover the sections in the manner described, but, before the immersion in turpentine, a dented wheel, such as is used for tracing patterns, is run along a line outside of the space containing the sections. Through the holes thus made the collodion comes in contact with the paper below the gummed surface and sticks to it. As soon as the treatment is finished, collodion-film and paper-support can easily be separated from each other, in either of the described methods, by cutting away the lines of margin where collodion and paper stick together.

b. The hardening of the collodion in the bath of turpentine takes place on removing the alcohol, ether and castor-oil, these being dissolved by the turpentine. For the purpose of doing this, as thoroughly as possible, a second bath of fresh turpentine is to be used. If work is continued, the liquid of the second bath can be used later as the first one. Warming the baths slightly will shorten the time required for the removal of the films from the liquids.

c. First, the surplus of turpentine is now allowed to drain off, then the support with the film is put between thick layers of filtering paper. This is repeatedly renewed, and the whole is subjected to a constant pressure for some time. The sections are not likely to be damaged by this pressure, if the collodion-film is not too thick, and has before been sufficiently hardened. Now a bath of equal parts by weight of chloroform and 95 per cent. alcohol is employed from one-quarter to one-half of an hour, to remove the last traces of turpentine. If then transferred

to alcohol of 80 per cent. both film and support will be moistened by it. This fact will prove that the turpentine has been successfully removed. In this alcohol of 80 per cent. the sections may be preserved for any length of time.

To proceed, a bath of 10 per cent. alcohol follows until the film is thoroughly soaked. After this is done sections and film moisten, when in contact with aqueous solutions, and the sections can be stained by the proper staining fluids. When it is possible, however, it is advisable to add a small quantity of alcohol, as a small percentage of this in staining fluids greatly increases their penetrating power.

In case two different liquids—one as a mordant—are to be used to produce the staining, it is necessary to employ the mordant on the whole object before the embedding process, because in this way the collodion and paper are not stained, but only the sections. Over-staining is reduced in the usual way.

d. For the purpose of transferring the film and support to turpentine again, it is necessary only to dry both superficially between filtering papers and then to immerse them in creosote, oil of origanum or liquified carbolic acid (1 to 3 xylol, according to Weigert); or, better, to bring them first to alcohol of 80 per cent., before employing these liquids. Then lay this support—film underneath—on filtering paper soaked with creosote, and, after film and sections are made transparent, transfer to turpentine.

e. Finally, the borders or lines of perforations made by the dented wheel are cut off, film and support—film underneath—are laid on thin paper, on which is a coat of rosin and turpentine. Air-bubbles between paper and film must be avoided, and the paper, which has so far formed the support is pulled off. A coat of rosin in turpentine is applied to the now exposed lower side of the film, and another thin paper laid flat on this. Turpentine penetrating the thin paper must be blotted off.

Instead of enclosing thus in rosin and a provisory support, the film with the sections may be mounted on slides in the usual way. Numbers or notes, to be enclosed at the same time with the sections in the collodion-film, should be written on thin paper with a soft lead-pencil, or with india-ink.

PROCEEDINGS.

Meeting of February 7th, 1890.

Owing to alterations in progress at the rooms of the Society, the meeting was held in the Natural History Hall of the College of the City of New York.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Forty-five persons present.

Dr. William Stratford addressed the Society on "Methods in Photomicrography." This address was illustrated by a series of photomicrographic apparatus, and by a series of lantern slides showing stages of nettle-cells of *Physalia* ; living diatoms, mainly *Heliopelta* and *Triceratia* ; diatoms in stages of reproduction ; and injured frustules of diatoms. Perhaps the most beautiful exhibit of the collection was a *Suriella gemma*, taken under a Powell and Lealand 1/4, with oblique light from the prism, in the green band of the spectrum, showing most prominently the difficult "basket work."

Mr. L. Riederer read a Paper, entitled :—"The Ovipositor of *Cryptus samiæ*."

OBJECTS EXHIBITED.

1. Transverse section of ovipositor of the ichneumon fly, *Cryptus samiæ* : by L. Riederer.

2. A photomicrograph of *Pleurosigma angulatum*, × 4900, recently received from Zeiss : by P. H. Dudley.

Meeting of February 21st, 1890.

The President, Mr. P. H. Dudley, in the chair.

Sixteen persons present.

President Dudley read a Paper upon the Termites of the Isthmus of Panama, referring especially to the genus *Calotermes*. The Paper was illustrated by numerous specimens of different species, portions of nests, and destructive wood-borings, together with microscopic slides and photographs of nests, sent by Mr. J. Beaumont, of Colon, S. A. Mr. L. Riederer exhibited sections of Queens of Termites in connection with the above Paper.

Mr. Dudley was requested to repeat this Paper, with the illustrating exhibits at a subsequent meeting of the Society.

Dr. Paul Hoffman made some interesting remarks upon the "white-ants" of India.

Dr. Frank D. Skeel exhibited photomicrographs of sections of chalcedony and silicified wood, taken by lamp-light with an inch objective of his own grinding, and showed some prominent structural characters, photographed by polarized light. The mineral sections from which the photographs were taken, were ground by Mr. J. D. Hyatt.

Meeting of March 7th, 1890.

The President, Mr. P. H. Dudley, in the chair.

Twenty-one persons present.

Dr. Samuel Lockwood read a Paper, entitled "Fungi Affecting Fishes. An Aquarium Study. First Paper—*Saprolegnia*." This Paper is published in the present number of the Journal, p. 67.

The subject was also discussed by Messrs. Dean, Hoffman, Leggett and others.

Meeting of March 21st, 1890.

The President, Mr. P. H. Dudley, in the chair.

Twenty-five persons present.

Mr. Charles S. Shultz announced the death of Mr. Samuel Wilde, a Member of the Society.

Dr. Samuel Lockwood read a Paper, entitled "Fungi Affecting Fishes. An Aquarium Study. Second Paper—*Devæa*." This Paper was illustrated by numerous microscopical preparations, and is published in the present number of the Journal, p. 79.

OBJECTS EXHIBITED.

1. Wood-sections, prepared by Mr. Romeyn B. Hough : by Charles S. Shultz.
2. Diatoms, 384 forms from the "New Santa Monica Find," prepared by Möller : by E. A. Schultze.
3. The Koch and Woltz microscopical lamp : by Geo. E. F. Haas.

Mr. Haas discussed with several members of the Society some of the merits and defects of the operation of the bent glass rods of this lamp.

Meeting of April 4th, 1890.

The President, Mr. P. H. Dudley, in the chair.

Twenty-seven persons present.

Mr. William G. De Witt, of the Committee on Purchase of Objectives, reported that six low-power objectives had been purchased for the use of the Society.

The Corresponding Secretary read a communication from the University of Toronto, requesting the donation of publications for the refurnishing of the library of the University, lately destroyed by fire.

On motion of Mr. Charles F. Cox, the Publication Committee was instructed to donate to the University of Toronto, a complete set of the publications of the Society.

President Dudley, at the request of the Society, repeated his Paper of February 21st, 1890, on "The Termites of the Isthmus of Panama." Mr. Dudley introduced some recent work of Mr. J. Beaumont, of Colon, S. A., in connection with this subject, and illustrated his Paper by a full collection of the insects, and of specimens showing their operations. After the reading of the Paper, numerous lantern projections were thrown upon the screen, consisting of many photographic views taken from a train while in motion across the Isthmus, and also of many microscopical mounts of the Termites, prepared by Mr. L. Riederer, as announced below.

OBJECTS EXHIBITED.

1–9. Nympha of *Termes minimus.* First form, showing nine progressive states in the development continuously to the imago.

10–12. Nympha of *Termes minimus.* Second, or supplementary form. Showing three progressive states as above, the wing-pads remaining rudimentary.

13. Wing-pads of nympha of *Eutermes.*

14. Wing-stumps of young queen of *Eutermes.*

15. Rudimentary wings of supplementary queen of *Termes minimus.*

16. Serial, sagittal sections of abdomen of male *Termes testaceous.*

17. Serial, sagittal sections of abdomen of male *Eutermes* (*Termes miles nasutus*).

18. Transverse sections of abdomen of full grown queen of *Eutermes.*

19. Sagittal sections of abdomen of young queen of *Termes miles nasutus.*

20. Sagittal sections of abdomen of young queen of *Termes*, sp.

Dr. Edw. G. Love also exhibited twenty-five photomicrographs, mainly of crystals and vegetable tissues, taken by polarized light. Dr. Love stated that he had made many negatives with the use of polarized light ; that it frequently brings out details which cannot be discerned by ordinary light ; and that the method was well adapted to vegetable structures, such as starch-grains, wood-sections, &c. The subject was also discussed by Messrs. Dean, Cox and Dr. Skeel.

PUBLICATIONS RECEIVED.

The Microscope : Vol. X., Nos. 3, 4 (March, April, 1890).

The American Monthly Microscopical Journal : Vol. XI., Nos. 3–5 (March–May, 1890).

The Microscopical Bulletin and Science News : Vol. VIII., No. 2 (April, 1890).

The Natural Science Association of Staten Island, Proceedings : (March 13–May 8, 1890).

The San Francisco Microscopical Society, Proceedings : (February 26–April 23, 1890).

Bulletin of the Torrey Botanical Club : Vol. XVII., Nos. 3–5 (March–May, 1890).

The Journal of Mycology : Vol. V., No. 4—Vol. VI., No. 1 (December, 1889–March, 1890).

The Botanical Gazette : Vol. XV., Nos. 2–5 (February–May, 1890).

Psyche : Vol. IV., Nos. 138–140—Vol. V., Nos. 167–169 (October, 1889–May, 1890). Index to Vol. IV.

Entomologica Americana : Vol. VI., Nos. 4–6 (April–June, 1890).

Insect Life : Vol. II., Nos. 9, 10 (March, April, 1890).

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Agricultural Experiment Station of Cornell University : Bulletins Nos. 15, 16 (December, 1889–March, 1890).

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School of Mines Quarterly : Vol. XI., No. 3 (April, 1890). Index to Vols. I.–IX.

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Indiana Medical Journal: Vol. VIII., Nos. 9–11 (March–May, 1890).

The Satellite: Vol. III., Nos. 7, 8 (March, April, 1890).

The Hahnemannian Monthly: Vol. XXV., Nos. 4–6 (April–June, 1890).

Johns Hopkins University Circulars: Vol. IX., Nos. 80, 81 (April, May, 1890).

The American Lancet: Vol. XIV., Nos. 3–5 (March–May, 1890).

The Pacific Record of Medicine and Surgery: Vol. IV., Nos. 8–10 (March–May, 1890).

The National Druggist: Vol. XVI., Nos. 6–11 (March 15–June 1, 1890).

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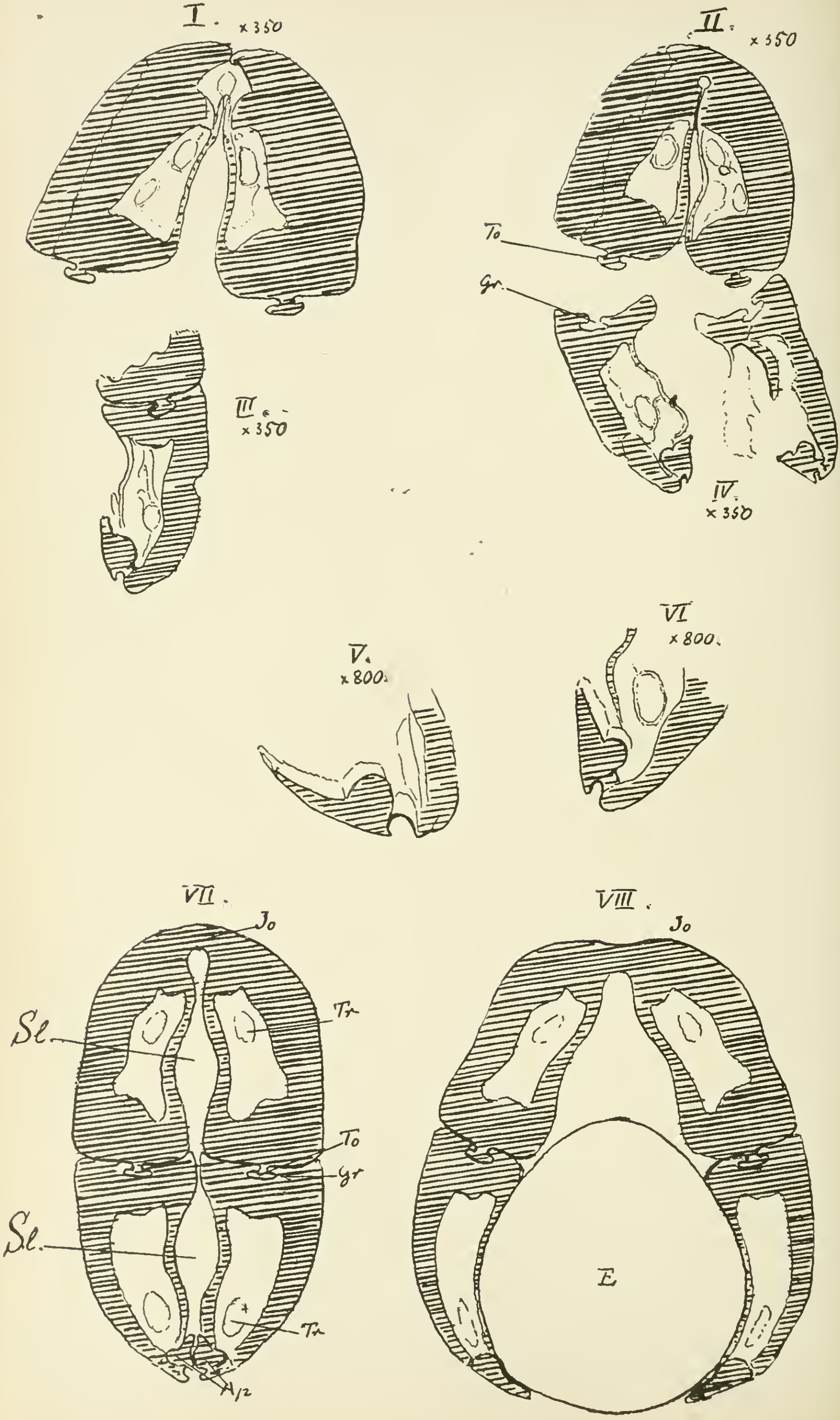

OVIPOSITOR OF CRYPTUS SAMIÆ.

Journal

of the

New-York Microscopical Society.

Vol. VI. October, 1890. No. 4.

THE OVIPOSITOR OF CRYPTUS SAMIÆ PACK.

BY LUDWIG RIEDERER.

(*Read February 7th*, 1890.)

The members of this genus of hymenopterous parasites are conspicuous on account of the length of the exserted ovipositor. This latter is composed of the ovipositor proper, and the two enclosing sheaths. These originate from the end of the abdomen, while the ovipositor proper protrudes from the ventral line of the abdomen, behind the sixth ring. The oviduct reaches this place in a forward direction, and there connects with the ovipositor, where it makes a bend downward and backward. As a consequence the thence straightening tube reaches far behind the body of the insect. Several bundles of muscles run from the point of exit of the ovipositor, in both an upward and backward direction, the latter bundles extending towards the anal end of the abdomen. The ovipositor proper is formed by one dorsal and two ventral parts, and they are fastened together in such manner that they can slide up and down upon each other, as far as the corresponding muscles in the abdomen will allow, but the parts cannot be separated sidewise.

Description of Plate 25.

I., II.—Dorsal parts, × 350.

III., IV.—Ventral parts, × 350. The combination of the tubes gives the greatest strength for the least material employed. The substance of the tubes is thickest on the sides of the surface, and near the tongues and grooves, and it is thinnest and most flexible on the sides which form the vertical slit. The soft substance and tracheæ are seen in the tube.

V., VI.—Appendices to ventral parts, connected by elastic joints, × 800. Figs. I.-VI. are drawn with the camera.

VII., VIII.—Diagrams to show the ovipositor while closed, and also while extended by the passing of the egg. Jo, Joint of dorsal part. Sl, Slit, forming passage for the egg. Tr, Tracheæ enclosed with soft substance in the tubes. To, Tongues. gr, Grooves. Ap, Appendices on the ventral parts. E, Egg.

When searching for information about the shape of the constituent parts, I could find only a few descriptions and sketches, and all of them were so indefinite that it was evident they were made more by employment of imagination than of actual observation. It is therefore interesting to study the shape of these parts, and their working together for their intended purpose. By means of the microscope we can see that the parts are barbed in different ways, as I showed at the meeting of January 4th, 1889. But, besides several lighter and darker shaded lines, we cannot find out much that is instructive about the form of the interior. The preparation of cross-sections does not furnish very promising results, because chitine—the main substance of the ovipositor—is so hard and brittle that out of a considerable number of sections sometimes none will show enough for an explanation. As the imago of the insect gave so little hope for success, I tried different states of development of the pupa, up to the time when the imago is just emerging, and this last state gave the best results.

The chitine skeleton of insects develops to the proper shape while the insect lies dormant as a pupa, and is still soft when the imago emerges, but hardens in a few hours, when out of the pupal skin. I had on hand a few cocoons of the large moth, *Platysamia cecropia*, infested with a brood of *Cryptus samiæ Pack.*, belonging to the family Ichneumonidæ, and thus I succeeded in procuring the different states of development. This insect gives the following approximate measurements: length of head, thorax and abdomen, 10 mm.; expanse of wings, 16 mm.; length of antennæ, 5 mm.; length of ovipositor, 6 mm.; diameter of the same, 0.2 × 0.1 mm.

The ovipositor, on the cross-section, shows that it is composed of four tubes, which are so compressed as to give an oval shape. The four tubes are all separated from each other, excepting the two dorsal ones. These are fastened together along the dorsal line into one single piece. At the line of contact between the dorsal and the ventral parts, the dorsal part has two projections or tongues, each one having the shape of the capital letter, "T." These T-shaped tongues are fitted into grooves of the same shape in the ventral parts. By this arrangement the dorsal and the two ventral parts can slide alongside of each other, as far as the muscles inside the abdomen will allow; but, by the same

arrangement, they are prevented from separating laterally. As the two dorsal parts are fastened together in one piece only along a fine line on the surface, this allows the two parts to be separated from each other for a certain distance, like the two sides of a hinge. Yet as soon as any force ceases to separate them, the elasticity of the joint will bring together again the two sides of the ovipositor. The passage of the egg from the oviduct into the slit, formed by the two sides of the ovipositor, tends to separate these parts, and at the same time, by the elasticity of these latter, the egg is firmly held in the slit. By the reciprocal movement of the sliding parts the egg is forced forwards. Yet the pressure exercised on the egg by this means is alleviated by the flexibility and thinness of the sides of the ventral parts forming the slit. Besides this the tube of the ventral parts is filled by a soft plastic substance, in which is embedded a trachea of good size, all acting like an air-cushion. Two small projections at the edges of the ventral parts prevent the egg from escaping sidewise. When not in use, these "appendices" are kept between the two ventral parts, close to their inner sides, by the elasticity of the connecting joints.

The pupa shows five wide tubes, bent around the end of the abdomen, and reaching well forward on the dorsal part of the insect. In these five tubes are contained, separate from each other, the one dorsal part, the two ventral parts, and the two sheaths. The less the development of the pupa has progressed, the less is visible of the finer structure of the single parts. The parts representing the tubes of the future ovipositor proper are homogeneous, showing no, or, later on, but slight differentiation. In the dorsal part no slit is visible, and but a trace of the projecting tongues, and the grooves in the ventral parts do not yet appear. Thus the union of the one dorsal and the two ventral parts of the pupa, into the ovipositor of the imago, takes place at the time when the mature insect bursts open the pupal skin, and forces its way out. Then the soft tongues enter the grooves, and the parts assume their proper shape and hardness. In this manner, it seems to me, takes place the formation of the ovipositor, a complex organ, composed of the formerly separated single parts.

THE TERMITES OF THE ISTHMUS OF PANAMA.

BY P H. DUDLEY, C. E.

(*Read April 4th*, 1890.)

In the previous paper on "Termites from the Isthmus of Panama," it will be remembered I stated three genera had been identified by Dr. Hagen, viz.: *Termes*, *Eutermes* and *Calotermes;* the first being represented by five (5) species, the second by three (3) species and the third by only one species. With one exception, the injury and destructive work to buildings, wood-work, cars, locomotive cabs, and furniture, had been done by species of the *Termes* and *Eutermes*. The exception was the injured portions of a first-class coach in daily service, attacked by *Calotermes marginipennis Latrielle*, as identified by Dr. Hagen. This species is found in Mexico, Central America, and California, though possibly not a native of that State. It is now known that they are frequently transported from one country to another, in trunk frames and wooden utensils.

During the past year a number of species of *Calotermes* have been found upon the Isthmus, and much more is now known of their habits in that locality. With the exceptions of their great destructiveness to sound wood-work, and rapid increase in numbers, they materially differ from either of the other two genera.

The *Calotermes* on the Isthmus do not have a distinct class of members, known as workers, and, in the large communities, only a small percentage of soldiers have been found.

No evidence of the *Calotermes* constructing large nests or galleries on the exterior surfaces of wood-work, trees, or even buildings, has so far been found upon the Isthmus. After entering a piece of wood-work or furniture, through a small crevice of a joint, or by boring an orifice from an adjacent piece of wood, they eat out the interior, in small pockets, entering each by a small orifice on the side, only sufficient to admit one insect at a time. Mr. Beaumont thinks, there being no extensive galleries, the small amount of guard-duty required, explains in a measure why there are so few soldiers. They are the only blind members in the community, and, being wingless, they do not swarm.

Only small queens of the genus *Calotermes* have been obtained upon the Isthmus, but there are great numbers of them

in the large communities, and the increase in numbers is very rapid. In the seat-rails in the coaches, which were destroyed by *Calotermes marginipennis Latrielle*, Mr. Beaumont estimated that nearly one-half of the number of the insects was females.

The *Calotermes* are dangerous pests, from their secluded habits. And, with one exception, they scarcely give any indication that they are in wood-work of buildings, coaches or furniture. The exception is the presence of little pellets of partially digested wood, about $\frac{1}{50}$ of an inch long, and $\frac{1}{100}$ of an inch in diameter. These are found upon the floor. In eating out the pockets in the wood they are careful to leave a thin partition between adjoining pockets. This is undoubtedly due to the instinct of danger from breaking through a surface I have one pocket which probably was one of the first constructed in the wood, and subsequently the wood surrounding it was eaten, leaving it intact, its support being derived from the tube, which was formed by leaving the wood containing the orifice or entrance to the pocket. No evidence has been found of the *Calotermes* repacking the excavated wood with solid material, making it into nests, as is the case with the *Termes.*

Sometimes a pocket will be found partially filled with the loose pellets before mentioned, but the majority are empty.

Because the *Calotermes* have no workers, in the sense of the other genera, I do not wish to convey the impression that they are idlers. On the other hand, they are very aggressive and voracious, eating hard, sound woods, which the other genera are not as liable to do. From the fact that the hard, sound wood wears away their mandibles, I am induced to think that naturally they live on soft wood or that undergoing decay.

In a recent communication I partly explained the reason of their ability to eat hard woods, notwithstanding the fact that the wood wears off the cutting portions of their mandibles, *i. e.*, the anterior teeth by which they sever the wood from the block. So far as now observed by Mr. Beaumont, and judging by the specimens of insects of the *Calotermes* sent to me, a large percentage of a community is composed of larvæ and nymphæ. A nympha will undergo several moultings before reaching the imago state, and at each moult will be provided with a new set of mandibles, replacing the older worn ones, and the wood cutting goes on with little interruption. When the mandibles of the imago

are worn, it is fed. Slide No. 32 shows the position of the mandibles for cutting wood. Mastication of the chip is performed by the posterior dentition. Slide No. 4 shows the worn mandibles.

Mr. Beaumont had several young *Calotermes* queens in white ash blocks for observation under his microscope, and saw them frequently cut a chip from the block. When the queen's mandibles became so worn that she could not do so, then she would starve. If, however, nymphæ were put in the block, which could cut the wood ana feed the queen, then she would thrive. Mr. Beaumont's ash blocks are 3¼ inches long by 1¼ inches square, on the upper side of which he grooves to receive a glass slide. Under the slide he cuts small V-shaped grooves into which he places a few living members of different species, and then covers them with the glass slide. In this way he could put the blocks under the microscope and observe the insects, and he learned more of their habits than could have been done in any other way. In many of these blocks he had pairs of several different species of Termites with two or three eggs, and as many larvæ.

Before mentioning some of these observations, I will describe how he obtained the little colonies he placed in his blocks, as it illustrates an interesting phase in the life-history of the Termites, and is common to the three genera upon the Isthmus. On the beach at Colon, in Coral avenue, near his house, and the shops of the Panama Railroad, stands a large Coccoloba, or sea-grape tree. It is really a tree of refuge for insects. I have two photographs of the tree taken from opposite sides. It will be noticed the tree is inclined, due to the constant direction of the trade-winds during the dry season, corresponding to our winter and spring. The bark of the Coccoloba is rough, thick and comparatively soft. The older layers are easily penetrated by insects. Mr. Beaumont says larvæ of a species of saw-fly bore into the bark, forming a small pocket, which is soon vacated. The entire life-history of this fly is shown in a series of vials with exhibit No. 26.

In the vacant pockets a pair of Termites finds a hiding place. Species of all genera upon the Isthmus have been found in the bark, all within the space of a few inches square. Each is, however, entirely distinct, without any connection one with the other.

Finding these little pockets occupied with pairs of Termites, Mr. Beaumont cut out portions of the bark, containing pockets and little colonies, and transferred them to recesses prepared in his ash blocks. The first pair transferred had two larvæ and seven eggs. Some of these eggs hatched, one producing the larva of a *nasuti* soldier, and others the larvæ of workers. These continued to thrive for four or five months, but they did not like the light, or their doings investigated, and tunneled under the bark, keeping out of sight. As long as they could be observed, the queen cared for the larvæ at first, but as soon as the larvæ workers were a few days old they also assisted. One or two moultings occurred, which occupied about one hour of time. This was much shorter than the observed time for transformations of the *Calotermes.* The queens found in these pockets are very small, but little larger than when they swarm and lose their wings. Making sections of the queens in this stage eight to ten nearly mature eggs are found. But little development, however, has taken place in the ovarian tubes beyond the nearly mature eggs.

This feature has been noticed by others, when making dissections of the young queens after swarming. The true explanation of this is yet to be ascertained. Several pairs of *Calotermes* were transferred from the Coccoloba tree to the ash blocks. They did not object to the light, and their movements and actions were readily studied.

One pocket contained a pair and three eggs. Mr. Beaumont had the pleasure of seeing a larva emerge from the egg, and in an hour or two saw it take its first supply of food, while observing it under the microscope.

The larva, crawling to the posterior of the queen's abdomen, touched it with its antennæ, opened its mouth and received a supply of some fluid food. This statement only applies to the *Calotermes;* feeding of the larvæ of the other genera, has not been reported by Mr. Beaumont.

The little pellets of partially digested wood are also used as food by the *Calotermes*, being fed to the imago with worn mandibles, and to the youngest nymphæ as now observed. Mr. Beaumont finds when a queen and larva are placed in one of his ash blocks, the larva flourishes as long as the queen can cut the food from the block. But when her mandibles become so worn that she can not do so the larva dies, and eventually the queen.

Mr. Beaumont found in the Coccoloba tree a small colony of *Calotermes*, the soldier of which is like the one figured by Dr. Hagen as *Calotermes flavicollis*. The largest of these soldiers was ¾ of an inch long, and was armed with powerful mandibles. Several more soldiers from the same nest were over ½ of an inch long, and had the appearance of not being fully grown. These are by far the largest soldiers from the Isthmus so far discovered, and are shown as specimens No. 5.

No large colonies of the same species have been found upon the Isthmus, though they may exist. *C. flavicollis* is not known to have been found in Central, South, or North America, but is in Spain, Italy and Egypt. A large amount of the plant used in the excavation of the Suez Canal went to the Isthmus, and it is possible, *Calotermes flavicollis* was in the timber portions of the plant.

It will be remembered that I stated that in the communities of the *Termes* and *Eutermes*, beside a queen, or queens and kings, their were soldiers and workers, the latter being many times the most numerous. Of young there would be larvæ and nymphæ of several ages, many of the latter with long wing-cases developing into winged imagines, both male and female, previous to the swarming season. The winged imagines all have eyes, and swarm, while the soldiers and workers are blind, and do not swarm. The soldiers do guard-duty and defend the community against minor attacks, though, when the community is attacked in great numbers, the workers assist in the defence. Mr. Beaumont watching *Termes testaceus* swarm, from a nest in a yellow pine sill, said the soldiers surrounded the orifice from which the insects issued, and stood guard with their mandibles open.* Upon the workers devolves all the labor of nest building, construction of the extensive systems of galleries, tunnelling the wood, rearing the young, and caring for the queens.

Mr. Beaumont, who has watched several species of the *Termes* and *Eutermes* in his glass termitaria, says the work is done in a very orderly, and systematic manner.

The soldiers of the *Termes* have long sickle-shaped mandibles, operated by powerful muscles.

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* Observations of May, 1889.

The heads of the soldiers of the *Eutermes* terminate in a long beak, containing a tube or gun, from which a glutinous shot can be thrown. This is a singular provision of nature. The smallest member of the community being provided with such an effective weapon, that at some distance one can put an antagonist even twice his size *hors de combat*, the legs and antennæ of the latter rendered useless by the quick drying viscid shot. Cuts of the heads of the *nasuti* soldiers will be found in my previous paper.

As complex as the members and habits of a *Termes* community may seem from the above; I have now a series of specimens of *Termes minimus* Beaumont, showing them to be far more complex.

These specimens have just been received from Mr. Beaumont, and are the most complete of any series known of a single species. In the genus *Termes*, besides the true queens and kings, there are supplementary queens and kings, and several stages of larvæ and nymphæ incident to the latter forms.

The fact of there being two classes of queens was stated as early as 1856 by Mr. Charles Lespes, in his investigations of *Termes lucifugus* at Bordeaux, France.

Dr. Fritz Müller made a series of observations in Brazil, confirming the general fact, and sent some of his results to Mr. Charles Darwin.

In 1872 Müller published his observations, which were of a longer duration than Lespes, and included species of the three genera we have mentioned. When he speaks of *Eutermes*, I am unable to determine whether he means species with mandibles, or those with beaks. In some details Müller does not agree with Lespes, but confirms the general facts.

Lespes found in the species of *Termes lucifugus* nymphæ of two forms, viz.:

1st. Those with long wing cases.

2nd. Those with short wing cases.

He designated the 1st as nymphæ of the first form, and the 2nd as nymphæ of the second form.

He stated, from the 1st form came the large queens and kings, and from the 2nd form small queens and kings, which are now designated as supplementary. Lespes stated that the winged imagines from the nymphæ would swarm the last of May or the fore part of June.

The nymphæ of the 2nd form would remain in the nest. At the time of the swarming of the imagines from the 1st form, Lespes states that he never saw a winged imago from the nymphæ of the 2nd form, but expects there would be, swarming tak ng place in August or September. The last was merely conjecture, and Müller says, according to his observations, was wrong. He found the wing-cases of the nymphæ of the 2nd form to be only rudimentary, and the imagines from them being wingless remained in the old nest.

The specimens of the nymphæ of the 2nd form, the imago and gravid queens, sent up by Mr. Beaumont, only have rudimentary wing-cases, and could not swarm. Three stages of larvæ and nymphæ have so far been found by Mr. Beaumont of the 2nd form, and he expects to find others. Interesting as this matter is scientifically, it is equally so practically.

Ample provision seems to be made for the dissemination of the inmates of a colony to form new ones, and at the same time fully providing for the perpetuation of the old one, making it very difficult to destroy a well-established colony.

Mr. Beaumont finds many of the nests destroyed by taking out the queen-cell and the queen or queens, were rebuilt in a few months, containing other queens. It will be remembered that in my previous paper I stated, when the galleries leading to and from a nest were destroyed, they were soon rebuilt. The latter will be more readily understood after seeing a lantern view of a nest.

The habits of each of the three genera of Termites, found upon the Isthmus, are so different that remedies, which may be effectual against one genus, may not be so against another, and in order to carry out practical measures, checking their destructiveness, it has become necessary to designate each genus so that ordinary workmen can distinguish them.

In my paper of last year, I stated that *Eutermes*, was made a sub-genus of *Termes*, owing to a peculiar venation of the wing. This means of classification included species having soldiers with mandibles, and species having soldiers with beaks in the same genus. On the Isthmus the venation of the wings is not constant, nor can winged insects be found at all seasons of the year. And authorities do not agree in identification. In my first paper, for the time being, I called all those species with

beaks *Eutermes*. This by no means avoids the confusion in the matter. And further study indicates that the habits of the two genera are so different that I now propose to call all those species having soldiers with beaks *Milesnasitermes*, soldier-nosed-termes.

The workmen know when they break a gallery and find a mandibulate soldier that the nest is likely to be inside of some post or beam near by, unless it should be a species of *Termes columnar*, in which case it is likely to be a mud nest, rising from the ground. These Termites belong to the genus *Termes*. On the other hand, when they break a gallery and find a soldier with a beak, the nest may be a long distance from that point, but it will be on the exterior of the wood, or tree. These Termites belong to the genus *Milesnasitermes*. If the workman does not see any exterior galleries, but finds a few little pellets of wood, on the floor, he knows the *Calotermes* are in the wood. The remedy in each case must be different. These simple designations can be understood by those, who must deal with the subject practically.

Lantern-slide No. 4 shows the representation, nearly full size, of one of the largest nests of *Milesnasitermes* yet found upon the Isthmus. It was in a store-house, and was 10 ft. in height,—greatest width 2½ft., and greatest depth 1½ft., estimated weight 300 lbs. The wood of the building was badly injured, while galleries ran from this to other buildings. One gallery ran to a chapel, and the organ was destroyed.

Slide No. 5 shows a mud nest of *Termes columnar*, at Ceroyal Station of the Panama R.R., on the Pacific slope. It is over 5ft. in diameter on the base, and nearly 4ft. high. It is very strong and readily holds up a man. These mud nests have only been discovered on the Pacific slope. A species quite similar has been found on the Atlantic slope, having a nest in a rotten stump.

Slide No. 6 shows Mr. Beaumont's study at Colon. On the table is his microscope and several of the ash blocks containing Termites for examination. It probably can be noticed that the table legs are in jars of water, which is a common custom on the Isthmus, to keep the Termites and common ants from the table.

On the table are two of Mr. Beaumont's glass termitaria,

each with a colony from the same nest of *Termes columnar.* He had a bridge connecting them, and the inmates built a gallery on it, and passed to and fro. He then took away the bridge, and each colony raised up a vertical gallery, one 11½ inches high, the other 7½ inches. A portion of a large nest of *Termes columnar* is shown on the table, which is cylindrical.

Slide No. 7 shows nests, galleries, queen-cells and one specimen of wood-tunneling by the *Calotermes.* The object of chief interest is a bridge, on which are built two galleries by two different species, which he had in one jar. The nests were side by side, without communication, and when they wished to cross the bridge each built a covered gallery.

It is hardly necessary to state that the beautiful slides of sections of the queen Termites were prepared by Mr. Ludwig Riederer, to whom I am much indebted for his invaluable assistance in the study of the anatomy of the Termites.

SPIRAL, OR ELLIPTICALLY WOUND TRACHEIDS, IN THE AXILLA OF SMALL DECAYED BRANCHES IN TREES.

BY P. H. DUDLEY, C. E.

(*Read January 17th*, 1890.)

The spiral, or elliptically wound tracheids, in the pieces of Yellow Pine, *Pinus palustris*, Mill., and White Cedar, *Chamæcyparis Sphæroidea*, Spach, before you this evening, are evidences of some of the wonderful phenomena, which trees possess during growth, of preserving the integrity of their structures.

I called your attention to these features last year, having noticed them very frequently in the above woods.

Continued work upon the decay of woods the past season leads me to believe, that similarly wound tracheids or fibres will be found in most species of wood grown in dense forests, where, for want of light, the lower branches die, are attacked by fungi, break off, and the stub is overgrown, the entire process constituting a system of natural pruning and protection. The more we study this process the more instructive and marvellous it becomes. For the growing cells of the trunk promptly take

in the situation, and effectually, as a rule, do that which is necessary to protect those already formed from the attacks of the fungi, and build up and carry on the structure of the tree unimpaired.

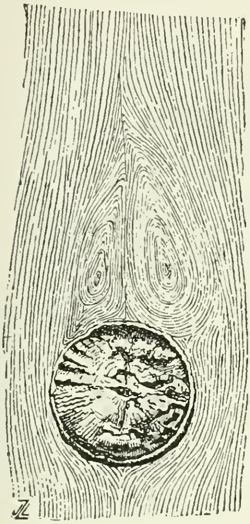

FIG. 1.

It is now well known that it is the function of many of the fungi by growth to undo the structure of the wood, cause it to decay, and reduce it to elements which again can be used by growing trees or plants.

For the growth of fungi, three conditions in combination are essential, viz.: 1st, *Moisture*; 2nd, *Heat*, ranging from 35° to 140° Fahr.: 3d, *Air*.

Eliminate any one of these conditions, and the growth of the fungi is checked, the wood not decaying.

To more readily trace the features of the natural system of pruning, and to see how the tree eliminates one of the conditions for the growth of the fungi, it will be well to recall to our minds a few facts regarding the growth of trees. They increase their height, year by year, by successive additions to the length of their leaders or leading branches.

When the lateral branches shoot off from the trunk, their height remains practically the same distance from the ground, as the tree grows. Whether all those branches will continue to develop, or the lower ones die, depends largely upon the amount of light the tree receives. Therefore, if the tree grows in an open field, it will be surrounded by light on all sides, which, acting on the chlorophyll in the leaves, will maintain the vigor and growth of all the branches. The trunk of the tree will be comparatively short, having many lateral branches. In this case, little if any natural pruning has taken place. On the other hand, when trees grow in the dense forests, only the uppermost branches receiving sufficient light for development, the lower ones being shaded, become dwarfed, die and are attacked by fungi. The

process of natural pruning takes place, and as a result those trees have tall branchless trunks, to the head of the tree.

From the above we can understand what is shown to have taken place in the specimens of wood before us.

Fig. 1 is a representative of the tangential section of Yellow Pine, enlarged to 1½ diameters, showing the elliptically wound

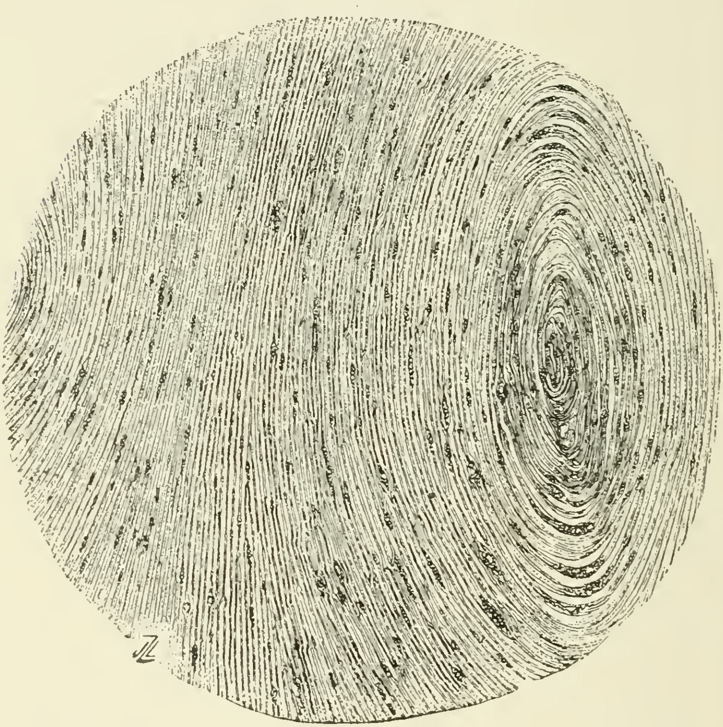

Fig. 2.

tracheids, which have formed in the axilla of the dead branch. Fig. 2 shows a portion of the same tracheids, enlarged to 15 diameters.

Figs. 3 and 4 show similarly wound tracheids from the White edar. Fig. 3 is enlarged to 1½ diameters and Fig. 4 to 15 diameters.

As soon as the lower branches die, the tree not only makes strenuous efforts to protect itself from the attacks of fungi

around and through the limb, but also to rid itself of the useless member. The cells of the cambium layer of the branch no longer being active those of the trunk are rolled out, pressing firmly against the lower, right and left sides of the branch, over the upper side, or the *axilla* of the branch, the expanding cambium layer would be separated for a short distance, leaving a triangular, or heart-shaped space. To close up this space is the function of the spiral, or elliptically wound tracheids. At first there is usually but one series ; but as the tree increases in diameter, and the branch is compressed in diameter, a second, and, sometimes, a third series form, as is the case of the White Cedar illustrated.

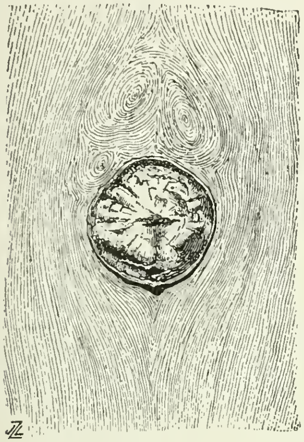

FIG. 3.

This tree growing in swampy ground, is a slow grower, and a durable wood. It decays slowly, even when attacked by its special fungus, *Agaricus campanella*, Batsch. It takes many years for the wood to grow over the stub of the decayed branch, and in many cases the fungus will work through the stub to the upright cells of the tree, and start a small zone of decay. The increasing spirally wound tracheids check the air supply, eventually cutting it off, eliminating one of the essential conditions in the combination for the growth of the mycelium of the fungus, and further decay of the living tree is arrested.

Timber cut from the White Cedar often shows many zones, where decay has started and has been subsequently arrested. In all cases these zones of decay have been started around the decayed branches, and arrested as described. The mycelium in these zones of decay will remain dormant for years, but will revive if the tree is cut into timber and used, when all of the conditions for the growth of fungi are in combination. Yellow Pine being a more rapid tree to grow than the White Cedar, the stubs of the decayed branches are more quickly overgrown, and we do not find the upright cells of the wood as frequently at-

tacked as in the White Cedar. The mycelium, however, of its special fungus, *Lentinus lepideus*, is frequently found in the overgrown stubs, and, when the wood is used for ties, it revives and fruits. It is very destructive to the wood, when the latter is used in contact with the soil ; the resin in the wood furnishing little resistance to its ravages.

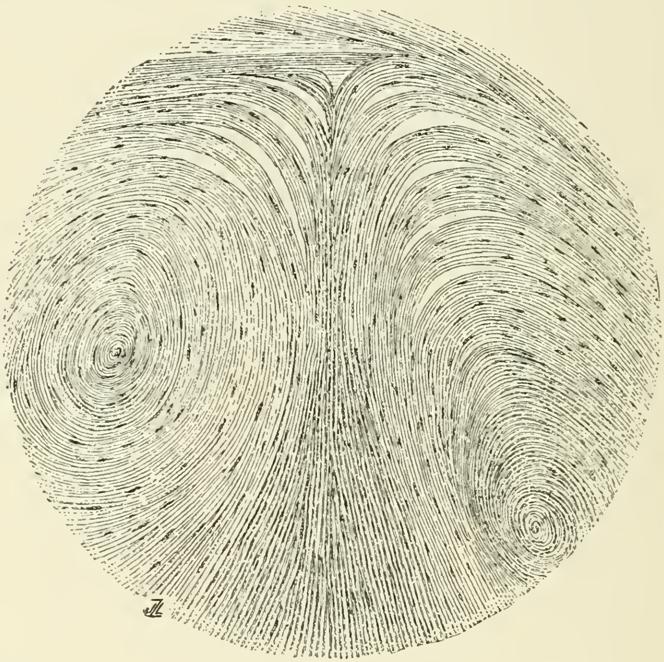

FIG. 4.

The growing trees of Yellow Pine protect the duramen of their trunks from its destruction, by closing up their wounds, shutting off the air supply and breaking the combination of conditions essential to its growth.

From these illustrations a very practical lesson is to be learned, and that is, in pruning trees, we ought to follow nature and protect the wounds, otherwise, if the tree cannot do it, the fungi will attack, and injure the tree.

PROCEEDINGS.

Meeting of April 18th, 1890.

The President, Mr. P. H. Dudley, in the chair.

Thirty-eight persons present.

Mr. L. Riederer read by title a Paper, entitled "Notes on Staining Sections made by the Paraffin-Process enclosed in a film of Collodion." This Paper is published in the present volume of the Journal, p. 88.

The six low-power objectives, announced at the last meeting as purchased for the use of the Society, were placed in the care of the Curator, and the Committee on this matter was discharged.

Dr. Frank D. Skeel exhibited a one-inch objective of his own grinding and mounting, and explained some points of interest in the combination. It is a triplet, the central glass, crown, with a radius of .41 inch, and the two outer glasses, flint, with radii of .80 inch. The combination gives good working distance, plenty of light, and good definition, and would be very useful for dissecting purposes. The skill and success of Dr. Skeel shown in the manufacture of this objective were commended by Mr. William Wales.

The Paper announced on the programme for the evening, and entitled "The Long Island Oyster" was read by Dr. Bashford Dean. This Paper was illustrated by black-board drawings, and by a large collection of interesting specimens. A discussion followed, participated in by Messrs. F. W. Devoe and F. W. Leggett, and Dr. Paul Hoffman.

Meeting of May 2nd, 1890.

The President, Mr. P. H. Dudley, in the chair.

In the absence of the Secretary, Mr. George E. Ashby was elected Secretary *pro tem.*

OBJECTS EXHIBITED.

1. Microscope stand and objectives, used by the late Dr. J. W. Draper in taking photomicrographs, and also specimens of these photomicrographs on daguerreotype plates; loaned for the occasion by his son, Dr. Daniel Draper: by P. H. Dudley.

2. Spiracles of the larva of the Nut-weevil.

3. Spiracles of the Roach.

4. Spiracles of Dragon-fly.

5. Spiracles of the larva of the Hawk-moth.

6. Spiracles of Cicada.

7. Spiracles of Bishop's Mitre.

Nos. 2–7 by F. W. Leggett.

8. A Turn-table modified for cutting cells : by Frank D. Skeel.

9. Sections of petrified wood from Cairo, Egypt, collected by Dr. H. Carrington Bolton : by T. B. Briggs.

10. Section of red Syenite from the Obelisk in Central Park, New York : by T. B. Briggs.

11. Spicules and gemmules of Sponge from nest of Termites, prepared by Mr. J. Beaumont, Colon, S. A.: by P. H. Dudley.

12. Pond-life ; *Melicerta ringens*, *M. tubicularia*, *Actinosphærium Eichhornii*, *Paludicella Ehrenbergii* (one week old) : by Stephen Helm, of 417 Putnam Avenue, Brooklyn, N. Y.

Mr. Dudley explained his exhibit of the stand and objectives used by the late Dr. J. W. Draper, and read an account of the process employed, as described in Dr. Draper's "Scientific Memoirs."

Dr. E. G. Love questioned the claim for Dr. Draper, that he had taken the first photomicrographs, and pointed to the facts that Sir Humphry Davy and Wedgewood in 1802, succeeded in producing photomicrographs by the sun-microscope, which, however, were not permanent ; that Dr. Hodgson in 1840, using the gas-microscope and daguerreotype plates, produced photomicrographs ; and that in France, in 1844, there was published an atlas of photomicrographs ; while Dr. Draper's work was done between 1851 and 1856.

Mr. F. W. Leggett described at length and in an interesting manner his exhibit of spiracles from six orders of insects.

Dr. F. D. Skeel described his modification of the turn-table for cutting cells and accomplishing similar work.

Mr. C. F. Cox said that he naturally felt interested in any modification of this useful accessory to the microscope, but he wished to improve this opportunity to protest against the unnecessary complication and expense, which had been introduced into the self-centering turn-table by manufacturers, since

he first brought it forward in 1875. Nearly all present makers, he believed, employed a coiled spring to move the clutches, and this was either so stiff as to need care to prevent its chipping the slide, or else was not stiff enough to permit of the application of a cutting tool to the cell while upon the table, and most of the arrangements, which had come under his notice, required the use of both hands to place or to release the slide. He felt sure that the right and left screw was altogether the most convenient, effective and economical mechanism for controlling the clutches, and thought the manufacturers would confer a great benefit upon the preparers of specimens if they would return to that original and simple device.

Mr. Stephen Helm, in relation to his exhibit, stated that in England he had never seen a branched *Melicerta*, while here such a form is very common, and seems peculiar to America. He had lately found one specimen with thirty-six branches.

Mr. Dudley explained the sections of petrified wood from Cairo, Egypt, and also the spicules and gemmules of sponge from a Termite's nest from Colon, S. A.

The Secretary announced that the Department of Microscopy of the Brooklyn Institute would hold its Annual Reception on the evening of the 8th inst., and that he had received programmes and tickets of admission for the use of the Society.

On motion it was resolved that the thanks of the Society be hereby tendered the Department of Microscopy of the Brooklyn Institute.

Meeting of May 16th, 1890.

The President, Mr. P. H. Dudley, in the chair.

OBJECTS EXHIBITED.

1. Sections of Chalcedony in agate: by T. B. Briggs.

2. Sections of a Meteorite, which fell May 2nd, 1890, in Iowa: by George F. Kunz.

3. Serial sections of the Brook Trout, two days from the egg: by L. Riederer.

4. *Termes flavipes*, soldier: by P. H. Dudley.

5. *Calotermes milesnasitermes*, soldier: by P. H. Dudley.

6. The same, young, with the beak just developing: by P. H. Dudley.

7. *Termes flavipes*, Kollar, worker: by J. L. Zabriskie.

8. The same, soldier: by J. L. Zabriskie.

9. The same, female, winged and fully developed preparatory to swarming: by J. L. Zabriskie.

10. Large cells and tunnels in wood, made by these Termites: by J. L. Zabriskie.

Dr. Dean explained, with black-board drawings, the remarkable points of Mr. Riederer's serial sections of the Brook Trout.

Mr. Dudley explained, with black-board drawings, the method of growth and repair of the beaks and mandibles of *Calotermes milesnasitermes*, and also read a communication from Mr. J. Beaumont, of Colon, S. A., a Corresponding Member of the Society, on the swarming of the Termites of that locality.

Mr. Zabriskie said of his exhibit: These are specimens of our only native species of Termite, and they are all taken from one colony, found, on the 10th of the present month, in a piece of White Pine plank lying on the ground, at the Water Works, Flatbush, Long Island. The region is so frequented by entomologists that nearly every available piece of wood lying upon the ground is turned, about once in every twenty-four hours, in search of prey. But this piece of plank happened to be concealed in a clump of shrubbery, and had probably lain undisturbed for a long time. The colony was strong in numbers, and the tunnels and cells excavated in the wood were unusually large. One of the cells here exhibited measures ½ × 1 inch in diameter, and three inches in length.

Colonies are abundant in this locality in decaying stumps, pieces of board, or in any other wood lying for any considerable time upon the ground. During this present season the first observed males and females with wing-pads were found in a decaying stump on April 19th. On May 7th, in another stump were found males and females further advanced, some still with wing-pads, but others with thoracic and abdominal rings becoming darkened, and with full-sized wings, although the wings of all were still ivory white. It will be observed that the female here exhibited, taken on May 10th, has the color of full development—head and rings nearly black, and wings transparent with dark veins. After the early days of June no winged specimens were found.

The following donations to the Library were made by Mr.

William G. DeWitt : Hand-Book of Invertebrate Zoology, W. K. Brooks ; Guide to the Microscope in Botany, Behrens ; The Microscope, vols. vi-ix ; Journal of the Postal Microscopical Club, 1882-1889.

Meeting of June 6th, 1890.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Fifteen persons present.

On motion the New York Mineralogical Club was invited to hold a joint meeting with this Society at the rooms of the latter on June 20th.

The Secretary read a Paper by Mr. George F. Kunz on the Meteorite recently fallen in Winnebago County, Iowa. Specimens of this were exhibited and commented on by Mr. T. B. Briggs.

The Secretary read a letter from Mr. J. Beaumont of Colon, S. A., upon the swarming of the White Ants, *Termes testaceus*.

Meeting of June 20th, 1890.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Forty-four persons present.

In the absence of the Secretary, Mr. Anthony Woodard was elected Secretary *pro tem.*

Mr. Charles S. Shultz, of the Board of Managers, made a statement of the proposed change of the place of meeting, from the present rooms to the first floor of the same building.

The joint meeting of the New York Mineralogical Club and the Society was addressed by the Rev. G. G. Rakestraw, of Philadelphia, on "Microscopical methods in Mineralogy, with especial reference to the mounting of opaque objects."

The Address was illustrated by a large number of beautiful and valuable specimens, as announced below, from the collection of the speaker.

OBJECTS EXHIBITED.

From the collection of the Rev. G. G. Rakestraw.

Native copper, chrysocolla, cuprite, azurite, hydrocuprite, malachite, native copper and cuprite, aragonite and selenite, Cornwall, Penn.

Copper ores from Utah, Colorado and Arizona, consisting of brochantite, clinoclasite, tyrolite, olivenite, conichalcite, cuprite, azurite and malachite.

Descloizite and brown vanadinite from New Mexico.

Vanadinite in a variety of forms from Arizona. Vanadinite in calcite, Collateral mines, Arizona.

Pharmacosiderite, scorodite and jarosite from Utah.

Lettsomite from Arizona. Lanthanite from Saucon Valley, Pennsylvania.

FOREIGN MINERALS.

Green garnets, Orford, Quebec, Canada.

Aurichalcite, Atacamite and Proustite : Chili.

Celestite, Sicily. Hematite crystallized from England.

Hematite crystals with double terminated quartz crystals on the sharp ages of the hematite, England.

Percylite, South Africa. Herrengrundite from Herrengrund, Hungary.

Pucherite, Saxony. Eleonorite, Prussia. Liroconite and Torbernite from Cornwall, England. Gothite in quartz. Variety of Pyrrhosiderite, Prussia, etc.

Also a large series of fine mounted minerals loaned by Mr. George W. Fiske, of Philadelphia, Pa.

On motion the thanks of the joint meeting were tendered the Rev. G. G. Rakestraw for this Address and exhibition.

Vice-President Hyatt announced the next meeting of the American Society of Microscopists, to be held at Detroit, Michigan, on August 13th, 1890.

On motion the Society adjourned until the first Friday of October next.

PUBLICATIONS RECEIVED.

The Microscope: Vol. X., Nos. 6–8 (June–August, 1890).

The American Monthly Microscopical Journal: Vol. XI., Nos. 6–8 (June–August, 1890).

The San Francisco Microscopical Society: Proceedings (June 4–September 17, 1890).

The Botanical Gazette: Vol. XV., Nos. 6–9 (June–September, 1890).

Bulletin of the Torrey Botanical Club: Vol. XVII., Nos. 6–9 (June–September, 1890).

Insect Life: Vol. II., No. 11—Vol. III., No. 1 (May–August, 1890).

Psyche: Vol. V., Nos. 170, 171 (June, July, 1890).

Entomologica Americana: Vol. VI., Nos. 7–9 (July–September, 1890).

The School of Mines Quarterly: Vol. XI., No. 4 (July, 1890).

Anthony's Photographic Bulletin: Vol. XXI., Nos. 11–18 (June 14–September 17, 1890).

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Academy of Natural Sciences of Philadelphia: Proceedings, Part 1. (January–March, 1890).

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Cornell University College of Agriculture: Bulletins Nos. 17–19 (May–August, 1890).

Kansas Experiment Station: Second Annual Report (1889).

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Experiment Station of Alabama: Bulletins Nos. 16–17 (June, July, 1890).

Experiment Station of Michigan: Bulletins Nos. 63, 64 (July, 1890).

Michigan Board of Agriculture: Report (1889).

The West American Scientist: Vol. VII., Nos. 50–52 (June–August, 1890).

Crystallogenesis: by Dr. H. Hensoldt (May, 1890).

United States Geological Survey: 8th Annual Report (1886, 1887).

The Brooklyn Medical Journal: Vol. IV., Nos. 7–9 (July–September, 1890).

Indiana Medical Journal: Vol. VIII., No. 12—Vol. IX., No. 3 (June–September, 1890).

The Satellite: Vol. III., No. 10—Vol. IV., No. 1 (June–September, 1890).

The Hahnemannian Monthly: Vol. XXV., Nos. 7–9 (July–September, 1890).

Johns Hopkins University Circulars: Vol. IX., No. 82 (June, 1890).

The Pacific Record of Medicine and Surgery: Vol. V., No. 1 (August, 1890).

The American Lancet: Vol. XIV., Nos. 6–9 (June–September, 1890).

The Electrical Engineer: Vol. IX., No. 110—Vol. X., No. 125 (June 11–September 24, 1890).

National Druggist: Vol. XVI., No. 12—Vol. XVII., No. 6 (June 15–September 15, 1890).

Mining and Scientific Review: Vol. XXIV., No. 24—Vol. XXV., No. 12 (June 12–September 18, 1890).

Journal of the Royal Microscopical Society: Parts 3, 4 (June, August, 1890).

Journal of Microscopy and Natural Science: Vol. III., No. 3 (July, 1890).

The Journal of the Quekett Microscopical Club: Vol. IV., No. 27 (July, 1890).

Grevillea: Nos. 88, 89 (June, September, 1890).

The Naturalist: Nos. 180–182 (July–September, 1890).

Nottingham Naturalist's Society: Transactions and Report (1889).

North Staffordshire Naturalist's Field Club: Transactions and Report (1890).

Natural History Society of Glasgow: Proceedings and Transactions, Vol. II., Part 2—Vol. III., Part 1 (1887–1889).

The Ottawa Naturalist: Vol. IV., Nos. 4–6 (July–September, 1890).

Proceedings of the Canadian Institute: Vol. XXV., No. 153 (April, 1890).

The Canadian Record of Science: Vol. IV., No. 3 (July, 1890).

The Victorian Naturalist: Vol. VI., No. 12—Vol. VII., No. 1 (April, May, 1890).

Société Royale de Botanique de Belgique: Comptes-Rendus (June 22, 1890). General Index (1890).

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Bulletin de la Société d'Études Scientifiques d'Angers (1885–1889).

Memoires de la Société Nationale des Sciences Naturelles de Cherbourg Vol. XXVI. (1889).

Nuovo Giornale Botanico Italiano: Vol. XXII., No. 3 (July, 1890).

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Société des Naturalistes de Kiew: Proceedings, Vol. X., No. 3—Vol. XI., No. 1 (1890).

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BIBLIOGRAPHICAL CATALOGUE OF THE DESCRIBED TRANSFORMATIONS OF NORTH AMERICAN COLEOPTERA.

BY WM. BEUTENMÜLLER.

(*Read by title November* 21*st*, 1890.)

The present catalogue was compiled by me in the spare time that was at my command during the past four years, and was originally intended for my own use and assistance in the study of the earlier stages of North American Coleoptera ; but seeing the imperfect condition of our knowledge, and the vast amount of work that is yet to be done in this neglected branch of entomology, I concluded to publish the results of my labor. to give those who may also be interested in the subject an idea of what work there has been done. It was my intention also to add notes and comments after the references so as to indicate their value, but lack of time prevented me from doing so. Yet I hope the catalogue, which must not be considered as being perfect, will be acceptable, until a better and more complete work can be substituted. I have searched for references in all the entomological publications of this country and Europe that were accessible to me, and I believe I have at least given the main facts that have been recorded on the earlier transformations of North American Coleoptera. In the arrangement and style of the catalogue I have followed Mr. Henry Edward's Bibliographical Catalogue of the described Transformations of N. American Lepidoptera (Bull. U. S. Nat. Mus. No. 35). When the words (quotes Horn, e. g.) occur after the name of the describer, it will be understood that the *text* of the description has been used, and when the words (after Packard, etc.) it signifies that the *figure* has been borrowed from this author. If the word (brief) is used it means that the reference is but a mere *notice* to a short description of the larva or pupa, etc., of the species.

CICINDELIDÆ.

AMBLYCHILA CYLINDRIFORMIS Say.

1845. Larva (brief). Leconte. Ann. Lyc iv. 143 (as *Pasimachus*).
1878. Larva (fig.). Horn. Trans. Am. Ent. Soc. vii. 29. pl. ii.
1877. Larva (brief). Williston. Can. Ent. ix. 163.
1878. Larva (fig.). Riley (Horn, Ms. in advance). 1st Rep. U. S. Ent. Com. 316.
1879. Larva. Schaupp (quotes Horn). Bull. Bk. Ent. Soc. ii. 3.
1883. Larva (fig.). Schaupp. Bull. Bk. Ent. Soc. vi. 74.

OMUS DEJEANI Reiche.

1878. Larva (fig.). Horn. Trans. Am. Ent. Soc. vii. 31. pl. ii.
1879. Larva. Schaupp (quotes Horn). Bull. Bk. Ent. Soc. ii. 3.
1883. Larva (fig.). Schaupp. Bull. Bk. Ent. Soc. vi. 75.

TETRACHA CAROLINA Linn.

1878. Larva. Horn. Trans. Am. Ent. Soc. vii. 34.
1879. Larva (brief). Schaupp (quotes Horn). Bull. Bk. Ent. Soc. ii. 3.
1883. Larva (fig.). Schaupp (quotes Horn). Bull. Bk. Ent. Soc. vi. 79.

CICINDELA REPANDA Dej.

1878. Larva (fig.). Horn. Trans. Am. Ent. Soc. vii. 35. pl. ii. fig. 4.
1879. Larva (brief). Schaupp (quotes Horn). Bull. Bk. Ent. Soc ii. 9.
1882. Pupa (fig.). Schaupp. Bull. Bk. Ent. Soc. v. 18.
1883. Larva (fig.). Schaupp (quotes Horn). Bull. Bk. Ent. Soc. vi. 123.

CICINDELA SPLENDIDA Hentz.

1878. Larva (fig. only). Riley. 1st Rep. U. S. Ent. Com. 314 (1877).
1885. Larva (fig. only). Riley. 4th Rep. U. S. Ent. Com. 95 (1883–85).

CARABIDÆ.

CALOSOMA CALIDUM Fabr.

1861. Larva (fig.). Rathvon. Rep. U. S. Dept. Agri. 59.
1863. Larva (brief, fig.). Fitch. 9th Rep. Trans. N. Y. Agri. Soc. 816.
1868. Larva (fig. only). Glover. Rep. U. S. Dept. Agri 79.
1874. Larva (fig. only). Le Baron. 4th Rep. Nox. & Ben. Ins. Ill. 42.
1875. Larva (fig.). Riley. 8th Rep. Ins. Mo. 52.
1876. Larva (fig. only) Thomas. 6th Rep. Nox. Ins. Ill. 89.
1878. Larva (fig. only). Riley. 1st Rep. U. S. Ent. Com. 314 (1877).
1878. Larva. Williams. Rep. Ent. Soc. Ont. 40.
1879. Larva (brief). Schaupp. Bull. Bk. Ent. Soc. ii. 14.
1879. Larva (fig. only). Comstock. Rep. U. S. Dept. Agri. pl. xi.
1879. Larva (fig. only). Burkhaut. Rep. Bd. Agri. Penn. 35.
1879. Larva (fig. only). Comstock. Cotton Insects. 175.
1880. Larva (fig.). Packard. Guide. 431 (7th Ed.).
1882. Larva, pupa (detailed). Schaupp. Bull. Bk. Ent. Soc. v. 33.
1884. Larva (fig.). Cutting, 8th Rep. Bd, Agri. Vermont. 251.

CALOSOMA SCRUTATOR Fabr.

1855. Larva (detailed). Capuis et Candeze. Mem. Soc. Sc. Liege. viii. 571.
1879. Larva (brief). Schaupp. Bull. Bk. Ent. Soc. ii. 14.

ELAPHRUS RIPARIUS Linn.

1867. Larva (fig.). Schiœdte. Nat. Tidsskr. iv. 452. pl. xiii.

PATROBUS LONGICORNIS Say.

1881. Larva. Schaupp. Bull. Bk. Ent. Soc. iv. 56. fig. and v. 18.

ANOPHTHALMUS sp.

1874. Larva (brief). Packard. Am. Nat. viii. 563.
1876. Larva, pupa (figs.). Packard. Am. Nat. x. 286.
1881. Larva (fig., detailed). Hubbard. Am. Ent. iii. 81.
1889. Larva, pupa (fig.). Packard. Mem. Nat. Acad. Sc. iv. 76.
These are supposed to be either *A. Tellkamfii*, or *Menetriesii*.

PTEROSTICHUS MUTUS Say.

1880. Larva (fig.). Schaupp. Bull. Bk. Ent. Soc. iii. 89.

PTEROSTICHUS LUCUBLANDUS Say.

1880. Larva (fig.). Schaupp. Bull. Bk. Ent. Soc. iii. 88.

AMARA OBESA Say.

1878. Larva, pupa (figs.). Riley. 1st. Rep. U. S. Ent. Com. 291, 292.

DICÆLUS DILATATUS Say.

1878. Larva (fig.). Schaupp. Bull. Bk. Ent. Soc. i. 1, 44.
1879. Larva (brief, fig.). Schaupp. Bull. Bk. Ent. Soc. ii. 21.
1882. Pupa (fig.). Schaupp. Bull. Bk. Ent. Soc. v. 18.

DICÆLUS POLITUS Dej.

1878. Larva, pupa (brief). Schaupp. Bull. Bk. Ent. Soc. i. 44, 72, and ii. 21 (1879).

DICÆLUS ELONGATUS Bon.

1878. Larva, pupa (brief). Schaupp. Bull. Bk. Ent. Soc. i. 43, 44, 72.
1879. Larva (brief). Schaupp. Bull. Bk. Ent. Soc. ii. 21.

DICÆLUS COSTATUS Lec., or SPLENDIDUS Say.

1878. Larva. Horn. Trans. Am. Ent. Soc. i. 37. pl. ii. fig. 5.
1879. Larva (brief.) Schaupp (quotes Horn). Bull. Bk. Ent. Soc. ii. 14.

BADISTER BIPUSTULATUS Fabr.

1872. Larva (fig.). Schiœdte. Naturh. Tidsskr. viii. pls. i, iii.

PRISTONYCHUS TERRICOLA Hbst.

1855. Larva (fig.). Chapuis et Candeze. Mem. Soc. Liege. viii. 376.

PLATYNUS EXTENSICOLLIS Say.

1880. Larva (fig.). Schaupp. Bull. Bk. Ent. Soc. iii. 91.

Galerita Lecontei Dej.

1848. Larva, pupa (fig.). Salle. Ann. Soc. Ent. Fr. 298.
1855. Larva. Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 367.
1879. Larva (brief). Schaupp. Bull. Bk. Ent. Soc. ii. 14.
1880. Larva, pupa (figs.). Packard. Guide. 433.
1880. Larva (fig.). Anony. Am. Ent. iii. 153.

Galerita janus Fabr.

1871. Larva (fig.). Packard. 1st. Ann. Rep. Inj. & Ben. Ins. Mass. 28–30, also reproduced in Guide. 713.
1875. Larva. Hubbard. Psyche. i. 48.
1879. Larva (brief). Schaupp. Bull. Bk. Ent. Soc. ii. 14.
1882. Pupa (fig.). Schaupp. Bull. Bk. Ent. Soc. v. 18.

Chlænius laticollis Say.

1880. Larva (fig.). Schaupp. Bull. Bk. Ent. Soc. iii. 17.
1882. Pupa (fig.). Schaupp. Bull. Bk. Ent. Soc. v. 18.

Chænius leucoscelis Chev.

1880. Larva (fig.). Schaupp. Bull. Bk. Ent. Soc. iii. 25, 26.

Harpalus herbivagus Say?

1876. Larva. Riley. 9th Rep. Inj. Ins. Mo. 97.
1878. Larva (fig.). Riley. 1st. Rep. U. S. Ent. Com. 290 (1877).

Harpalus. (?) sp. (?)

1869. Larva (fig. only). Packard (quotes Walsh). Guide. 434.
1874. Larva (fig. only). Le Baron (quotes Walsh). 4th Rep. Nox. & Ben. Ins. Ill. 47.
1876. Larva (fig.). Riley. 9th Rep. Nox. & Ben. Ins. Mo. 97.
1878. Larva (fig. only). Williams. Rep. Ent. Soc. Ont. 42.
1878. Larva (fig. only). Riley. 1st Rep. U. S. Ent. Com. 292.
1883. Larva (fig. only). Saunders. Ins. Inj. Fruit. 185 (as *H. Pennsylvanicus*).
1884. Larva (fig. only). Edge. Rep. Agri. Penn. 102 (as *H. Pennsylvanicus*).

Harpalus caliginosus Fabr. (?)

1879. Larva (fig. only). Comstock. Cotton Ins. 175.
1884. Larva (fig. only). Edge. Rep. Agri. Penn. 102 (as *H. Pennsylvanicus*).

HALIPLIDÆ.

Haliplus ruficollis De G.

1864. Larva (fig.). Schiœdte. Nat. Tidsskr. iii. 161-164.

DYTISCIDÆ.

DYTISCUS MARGINALIS Linn.

1634. Larva. Mouffet. Ins. Min. Animal. Theatr. 320.
1685. Larva (fig.). Swammerdam. Bibl. Nat. pl. xxix.
1749. Larva, pupa (fig.). Rœsel. Insect. Belust. i. 1-8. pl. i.
1758. Larva (fig., brief). Hill. Book of Nat. Hist. Ins. pl. xxix.
1774. Larva. De Geer. Mem. iv. m. 8.
1804. Larva, pupa (fig.). Latreille. Nat. Hist. Ins. & Crust. 70. pl. lxx.
1806. Larva. Clairville. Ent. Helvet. ii. 204.
1806. Larva (fig., brief.) Shaw. General Zoo. 91. pl. xxxiii.
1823. Larva, pupa. Latreille (quotes Rœsel). Regne Anim. 284, 285 (1817).
1826. Larva (fig.). Kirby & Spence (quote Rœsel). Intro. Ent. iii. pl. xiii.
1832. Larva, pupa (figs.). Lyonet. Recherches. 108. pl. xi (1760).
1832. Larva. Erichson. Gen. Dytis. 14.
1834. Larva, pupa (fig.). Sturm (quotes Rœsel). Ins. Deutsch. viii. 11. pl. clxxxvi.
1835. Larva, pupa (figs.). Audouin et Brulle. Nat. Ins. v. 194 pl.
1835. Larva (fig. only). Duncan. Nat. Library. ii. 136.
1836. Larva. Curtis. Trans. Ent. Soc. Lond. i. 86.
1836. Larva (fig.). Heer (quotes Rœsel). Obs. Ent. pl. iii.
1839. Egg, larva, pupa (figs.). Westwood (quotes various authors). Int. Ins. i. 99-101.
1841. Larva, pupa (figs.). Jones. Anim. Kingd. 245.
1842. Larva (fig., brief). Anony. Rudiments of Zoology. 235.
1855. Larva (fig. only). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 383. pl. i.
1864. Larva, pupa (figs.). Schiœdte. Nat. Tidsskr. iii. 182. pl. iii.
1865. Egg, larva, pupa (brief, figs.). Houghton. Intellect. Obs. vi. 422.
1870. Larva. v. Fricken. Nat. and Off. xvi. 474.
1872. Larva, pupa (figs., brief). Figuier. Insect World. 479.
1874. Larva, pupa (figs. only). Le Baron. 4th Rep. Nox. Ins. Ill. 40.

CYBISTER FIMBRIOLATUS Say.

1885. Larva, pupa (figs.). Duges. Ann. Ent. Soc. Belg. xxix. 27. pl. ii.

HYDROPHILIDÆ.

HELOPHORUS GRANULARIS Mots.

1862. Larva, pupa (figs.). Schiœdte. Nat. Tidsskr. iii. 1. 213. pl. vii.

HYDROPHILUS NIMBATUS Say.

1884. Larva, pupa (figs.). Duges (as *H. lateralis*). Ann. Ent. Soc. Belg. xxviii. 7. pl. i.

HYDROPHILUS TRIANGULARIS Say.

1881. Egg, larva (figs.). Garman. Am. Nat. xv. 661.

HYDROCHARIS OBTUSATUS Say.

1884. Egg-case (fig.), young larva. Bowditch. Journ. Bost. Zoo. Soc. iii. 1-6.

SPHÆRIDIUM SCARABÆOIDES Linn.

1862. Larva, pupa (figs.). Schiœdte Nat. Tidsskr. iii. 1. 221. pl. vi.

CERCYON ANALE Payk.

1862. Larva, pupa (figs.). Schiœdte. Nat. Tidsskr. iii. 1. 219. pl. vi.

PLATYPSYLLIDÆ.

PLATYPSYLLA CASTORIS Rit.

1888. Larva (fig.). Horn. Trans. Am. Ent. Soc. xv. 23. pl. iii.
1888. Larva (figs.). Riley. Scient. Am. Supp. June.
1889. Larva (brief). Horn. Pro. Ent. Soc. Wash. i. 144 (1888).
1889 Larva (figs.). Riley. Insect Life. i. 300–307.
1890. Larva (figs.). Riley. Ent. Am. vi. 27–30.
1890. Larva (fig.). Riley. Insect Life. ii. 244–246.
1890. Larva. Horn. Ent. Am. vi. 55.

SILPHIDÆ.

NECROPHORUS TOMENTOSUS Web.

1861. Larva (fig , brief). Rathvon. Rep. U. S. Dept. Agri. 594.
1881. Larva (fig., detailed). Schaupp. Bull. Bk. Ent. Soc. iv. 37, 38.

SILPHA INÆQUALIS Fabr.

Larva, pupa (figs.). Riley.
1874. Larva, pupa (figs., brief). LeBaron (quotes Riley). 4th Rep. Nox. Ins. Ill. 57.

SILPHA AMERICANA Linn.

1861. Larva (fig., brief). Rathvon. Rep. U. S. Dept. Agri. 595.
1882. Larva (fig., detailed). Schaupp. Bull. Bk. Ent. Soc. v. 2. pl. 18.

SILPHA RAMOSA Say.

1880. Egg, larva (figs). Gissler. Am. Ent. iii. 265.

SILPHA LAPPONICA Hbst.

1869. Larva (figs. only). Packard. Guide. 439 (and other editions).

SILPHA OPACA Linn.

1846. Larva. Guerin. Ann. Ent. Soc. Fr. iv. 2 Ser. Bull. 72.
1852. Larva. Fairmaire. Ann. Soc. Ent. Fr. 2 Ser.

ADELOPS HIRTUS Tellk.

1874. Larva (brief). Packard. Am. Nat. viii. 563.
1876. Larva (fig-only). Packard. Am. Nat. x. 286.
1880. Larva, pupa (figs., detailed). Hubbard. Am. Ent. iii. 80.
1889. Larva, pupa (figs.). Packard (quotes Hubbard in part). Mem. Nat. Acad. Sc. iv. 78.

STAPHYLINIDÆ.

QUEDIUS FULGIDUS Fabr.

1834. Larva (fig). Bouche. Nat. Ins. 180, 181. pl. viii.
1858. Larva. Kraatz (quotes Bouche). Nat. Ins. Deutsch. ii. 488.
1864. Larva (fig.). Schiœdte, iii. 205. pl. x.

LISTOTROPHUS CINGULATUS Grav.

1879. Larva (brief). Schaupp. Bull. Bk. Ent. Soc. ii. 30.
1881. Larva (detailed). Schaupp. Bull. Bk. Ent. Soc. iv. 9, 10.

STAPHYLINUS MACULOSUS Grav.

1861. Larva (fig., brief). Rathvon. Rep. U. S. Dept. Agri. 596.
1878. Larva (fig., detailed). Schaupp. Bull. Bk. Ent. Soc. i. 42, 71.
1879. Larva pupa (brief). Schaupp. Bull. Bk. Ent. Soc. ii. 30.

STAPHYLINUS VULPINUS Nordm.

1880. Larva (fig.). Schaupp. Bull. Bk. Ent. Soc. iii. 92.

STAPHYLINUS ERYTHROPTERUS Linn.

1724. Larva, pupa (figs.). Frisch. Beschreib. Ins. v. 50. pl. xxvi.

PHILONTHUS ÆNEUS Rossi.

1834. Larva (fig.). Bouche. Nat. Ins. 199. pl. vii.
1839. Larva (fig.). Westwood. Zoo. Journ. iii. 58, 59.
1858. Larva. Kraatz (quotes Bouche). Nat. Ins. Deutsch. ii. 567.
1864. Pupa (fig.). Schiœdte. Nat. Tidsskr. iii. 206. pl. xii.

PHILONTHUS SORDIDUS Grav.

1876. Larva. Mulsant. Hist. Nat. Brevip. 384.

XANTHOLINUS PUNCTULATUS Payk.

1834. Larva (fig.). Bouche. Nat. Ins. 181. pl. viii.
1858. Larva. Kraatz (quotes Bouche). Nat. Ins. Deutsch. ii. 631.

LEPTACINUS BATYCHRUS Gyll.

1876. Larva. Mulsant. Hist. Nat. Brevip. 324.

STENUS BIPUNCTATUS Er.

1873. Larva (fig.). Schiœdte. Nat. Tidsskr. viii. 548. pl. xviii.

TACHYPORUS CHRYSOMELINUS Linn.

1873. Larva (fig.). Schiœdte. Nat. Tidsskr. viii. 557. pl. xix.

OXYTELUS SCULPTUS Grav.

1855. Larva (fig.). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 400.
1858. Larva. Kraatz (quotes Chapius et Candeze). Nat. Ins. Deutsch. ii. 849.

ACIDOTA CRENATA Fabr.

1877. Larva, pupa (brief). Beling. Wieg. Archiv. 43. i. 50.

UNKNOWN SPECIES.

1876. Larva (fig). Packard. Am. Nat. x. 286. pl. ii. fig. 9.

1889. Larva (fig.). Packard. Mem. Nat. Ac. Sc. iv. 80.

TRICHOPTERYGIDÆ.

TRICHOPTERYX FASCICULARIS Hbst.

1846. Larva, pupa (figs). Perris. Ann. Soc. Ent. Fr. ii. 4, 465. pl. xi.

1847. Larva, pupa. Allibert (quotes Perris). Revue Zoo. 190.

1855. Larva (fig). Chapuis et Candeze (quote Perris). Mem. Soc. Sc. Liege, viii. 408.

PHALACRIDÆ.

OLIBRUS BICOLOR Gyll.

1857. Larva, pupa (figs.). Heeger. Sitzb. Ak. Wiss. Wien. xxiv. 330–334. pl. vi.

1867. Larva, pupa (brief). Kawall. Stett Ent. Zeit. xxviii. 118.

1874. Larva, pupa (brief). Kaltenbach. Pflanzen feinde. 349, 397.

COCCINELLIDÆ.

MEGILLA MACULATA Deg.

1888. Larva, pupa (figs.). Lintner. 4th Rep. Nox. Ins. N. Y. 83.

HIPPODAMIA AMBIGUA Lec.

1882. Larva, pupa (figs.). Riley. Rep. U. S. Dept. Agri. 206. pl. xviii.

1883. Larva, pupa (figs.). Saunders. Ins. Inj. Fruit. 416.

1884. Larva, pupa (figs.). Cutting. 8th Rep. Vermont Agri. 257.

HIPPODAMIA 13-PUNCTATA Linn.

1889. Pupa (fig.). Weed. Bull. Ohio Exp. St. i. 13.

HIPPODAMIA PARENTHESIS Say.

1860. Egg, pupa. Fitch. 6th Rep. Nox. Ins. N. Y. 851, 852.

HIPPODAMIA CONVERGENS Guér.

1868. Larva, pupa (figs., brief). Walsh & Riley. Am. Ent. i. 46, 143.

1869. Larva, pupa (figs. only). Packard. Guide. 511 (as *H* 13-*punctata*).

1870. Larva, pupa (figs., brief). Riley. Am. Ent. ii. 309.

1870. Larva, pupa (figs.). Shimer. Am. Nat. iii. 94.

1873. Larva, pupa (figs. only). Riley. 6th Rep. Nox. Ins. Mo. 51.

1874. Larva, pupa (figs. only). Rogers. Can. Ent. vi. 84.

1874. Larva, pupa (figs. only). LeBaron. 4th. Rep. Nox. Ins. Ill. 94.

1876. Larva, pupa (figs. only). Thomas. 1st. Rep. Nox. Ins. Ill. 173.

1877. Larva, pupa (figs. only). Packard. Half Hours Ins. 38.

1877. Larva, pupa (figs. only). Saunders. Rep. Ent. Soc. Ont. 36.

1878. Larva, pupa (figs. only). Thomas. 8th Rep. Nox. Ins. Ill. 173.

1879. Larva, pupa (figs. only). Comstock. Rep. U. S. Dept. Agri. pl. xii.

1879. Larva, pupa (figs. only). Comstock. Cotton Ins. 177.
1880. Larva, pupa (fig. only). Packard. Guide, 511.
1880. Larva, pupa (figs. only). Riley. Bull. No. 3. U. S. Ent. Com. 35.
1883. Larva, pupa (figs. only). Saunders. Ins. Inj. Fruit. 125.
1884. Larva, pupa (figs. only). Cutting. 8th Rep. Vermont Agri. 253.
1885. Larva, pupa (figs. only). Hubbard. Ins. Aff. Orange. 72, 73.
1885. Larva (fig. only). Riley. 4th Rep. U. S. Ent. Com. 96.

Coccinella 9-notata Hbst.

1860. Larva, pupa. Fitch. 6th Rep. Nox. Ins. N. Y. 842–846.
1862. Larva, pupa (fig.). Harris. Inj. Ins. Mass. 246.
1862. Larva, pupa (figs.). Sanborn. 10th Rep. Mass. Bd. Agri. 145.
1869. Pupa (fig. only.). Packard. Guide. 512 (and other editions).
1870. Pupa (fig. only.). Shimer. Am. Nat. iii. 94.
1877. Pupa (fig. only.). Packard. Half Hours. Ins. 209.
1877. Larva (fig. only.). Saunders. Rep. Ent. Soc. Ont. 30.
1878. Larva (fig. only.). Williams. Rep. Ent. Soc. Ont. 43.
1879. Pupa (fig. only.). Comstock. Cotton Ins. 176.
1879. Pupa (fig. only.). Comstock. Rep. U. S. Dept. Agri. pl. xii.

Coccinella sanguinea Linn.

1882. Pupa (fig.). Riley. Rep. U. S. Dept. Agri. 205. pl. xviii. fig. 4.
1883. Pupa (fig., brief.). Saunders. Ins. Inj. Fruit. 415.
1884. Pupa (fig. only). Cutting. 8th Rep. Vermont Agri. 256.
1885. Larva, pupa (figs.). Hubbard. Ins. Aff. Orange. 73.

Coccinella abdominalis Say.

1882. Larva, pupa (figs.). Riley. Rep. U. S. Dept. Agri. 203. pl. xviii.
1883. Larva, pupa (figs., brief). Saunders. Ins. Inj. Fruit. 431.
1884. Larva, pupa (figs. only). Cutting. 8th Rep. Vermont Agri. 256.
1886. Larva, pupa (figs.). Duges. Ann. Ent. Soc. Belg. xxx. 38. pl. iii.

Adalia bipunctata Linn.

1720. Larva, pupa (figs.). Frisch. Beschreib. Ins. pt. 9. 33. pl. xvi.
1762. Larva. Geoffroy. Hist. Ins. i. 320.
1775. Larva. DeGeer. Mem. v. 427.
1839. Larva (fig.). Westwood. Intro. Ins. i. 396.
1846. Larva. Mulsant. Hist. Nat. Col. Fr. 60.
1858. Larva, pupa (fig.). Letzner. Verw. der Coccinellen. 4.
1869. Egg, larva, pupa (brief.). Packard. Guide. 511, 512.
1874. Larva, pupa. Rogers. Can. Ent. vi. 83.
1878. Egg, larva, pupa. Williams (quotes Packard). Rep Ent. Soc. Ont. 44.

Vedolia cardinalis.

1889. Egg, larva, pupa (figs.). Coquillett. Insect Life. ii. 70.

Harmonia picta Rand.

1873. Larva, pupa (figs.). Riley. 5th Rep. Nox. Ins. Mo. 101.
1878. Larva (brief). Thomas. 6th Rep. Nox. Ins. Ill. 174.

1883. Larva (brief). Saunders. Rep. Ent. Soc. Ont. 56.
1883. Larva (fig. ,brief). Saunders. Ins. Inj. Fruit. 125.
1885. Larva (fig.). Lintner. 2nd Rep. Inj. Ins. N. Y. 186.

MYSIA 15-PUNCTATA Oliv.

1869. Larva, pupa. Packard. Guide. 512 (and other editions).
1871. Larva, pupa (figs. only). Reed. Can. Ent. iii. 170.
1872. Larva, pupa (figs.). Riley. 4th Rep. Nox. Ins. Mo. 18.
1874. Larva (brief). Rogers. Can. Ent. vi. 85.
1877. Larva, pupa (figs. only). Saunders. Rep. Ent. Soc. Ont. 36.
1878. Larva, pupa (figs. only). Williams. Rep. Ent. Soc. Ont. 43.
1882. Larva, pupa (figs). Harrington. Rep. Ent. Soc. Ont. 57.
1883. Larva, pupa (figs., brief). Saunders. Ins. Inj. Fruit. 130.
1887. Larva, pupa (figs. only). Fletcher. Rep. Ent. Exp. Farms. 28.

PSYLLOBORA 20—MACULATA Say.

1872. Larva. pupa (fig.). Packard. 3d Rep. Inj. Ins. Mass. 263.
1889. Larva, pupa (figs.). Weed. Bull. Ohio Agri. Exp. St. i. 3, 4. pl. i.

CHILOCORUS BIVULNERUS Muls.

1858. Larva, pupa (brief). Glover. Rep. U. S. Pat. Office (Agri.). 261.
1863. Larva, pupa (brief). Glover. U. S. Pat. Office (Agri.). 579.
1868. Larva (fig. only). Walsh. Riley. Am. Ent. i. 39.
1876. Larva (brief). Thomas. 1st. Rep. Inj. Ins. Ill. 174.
1877. Larva (fig., brief). Smith. 7th Rep. Inj. Ins. Ill. 128.
1877. Larva (fig. only). Saunders. Rep. Ent. Soc. Ont. 36.
1878. Larva (fig. only). Thomas. 8th Rep. Inj. Ins. Ill. 174.
1883. Larva (fig. only). Saunders. Rep. Ent. Soc. Ont. 56.
1883. Larva (fig., brief). Saunders. Ins. Inj. Fruit. 43.
1885. Larva (fig. only). Lintner. 2d Rep. Ins. N. Y. 186.
1885. Larva, pupa (figs.). Hubbard. Ins. Aff. Orange. 71, 72.

CHILOCORUS CACTI Linn.

1839. Larva (fig., brief). Westwood. Intro. Ins. i. 397.
1882. Larva. pupa (figs.). Riley. Rep. U. S. Dept. Agri. 205. pl. xviii.
1883. Larva, pupa (figs., brief). Saunders. Ins. Inj. Fruit. 415.
1884. Larva, pupa (figs. only). Cutting. 8th Rep. Vermont Agri. 257.

EXOCHOMUS CONTRISTATUS Muls.

1859. Larva, pupa (brief). Glover. U. S. Pat. Office. Rep. (Agri.) 261. (1858). (as *E. Guexi*).
1885. Larva, pupa (figs.). Hubbard. Ins. Aff. Orange. 72.

SCYMNUS CERVICALIS Muls.

1869. Larva (brief). Packard. Guide. 513.

SCYMNUS ARCUATUS Rossi.

1857. Larva, pupa (figs.). Heeger. Sitzb. Ak. Wiss. Wien. xxiv. 326-329, pl. v.

EPILACHNA BOREALIS Fabr.

1862. Larva (brief). O. Sacken. Proc. Ent. Soc. Phil. i. 125.
1867. Larva (fig. only). Walsh. Pract. Ent. ii. 42.
1869 Larva, pupa (brief). Packard (quotes O. Sacken). Guide. 513.
1883. Life History. French. Can. Ent. xv. 189.

EPILACHNA MEXICANA Guér.

1886. Larva, pupa (figs.). Duges. Ann. Ent. Soc. Belg. xxx. 40. pl. iii.

ENDOMYCHIDÆ.

MYCETÆA HIRTA Marsh.

1839. Pupa (fig.). Westwood. Intro. Ins. i. 154.
1849. Larva, pupa (figs.). Blisson. Ann. Soc. Ent. Fr. ii. 7. 315-325. pl. ix.
1863. Larva, pupa. Perris (quotes Blisson). Hist. Pin. Mar. i. 113-116.

APHORISTA VITTATA Fabr.

1886. Larva, pupa (figs.). Smith. Ent. Am. ii. 85.

EROTYLIDÆ.

LANGURIA MOZARDI Lat.

1879. Egg, larva, pupa (figs.). Comstock. Rep. U. S. Dept. Agri. 199, 200. pl. i.
1881. Egg, larva, pupa (figs.). Lintner (quotes Comstock). Trans. N. Y. Agri. Soc. 18 (1880).
1881. Egg, larva, pupa (figs.). Saunders (quotes Comstock). Rep. Ent. Soc. Ont. 44.
1887. Egg, larva, pupa (figs.). Cook (quotes Comstock). Beal's Grasses N. Am. i. 378-380.
1888. Egg, larva, pupa (figs.). Webster (quotes Comstock). Ins. Life. i. 19.

LANGURIA PUNCTICOLLIS Say.

1873. Larva, pupa (figs.). Packard. 3rd Rep. Inj. Ins. Mass. 23, 24.
1873. Larva, pupa (figs.). Packard. Am. Nat. vii. 544.

MEGALODACNE HEROS Fabr.

1873. Larva, pupa (figs., brief). Packard. 3rd Rep. Inj. Ins. Mass. 24.
1873. Larva, pupa (figs.). Packard. Am. Nat. vii. 545.

MEGALODACNE FASCIATA Fabr.

1890. Larva. Beutenmüller. Psyche. v. 318

MEGALODACNE ULKEI Cr.

1878. Larva, pupa (brief). Dury. Can. Ent. x. 210.

ISCHYRUS 4-PUNCTATUS Oliv.

1855. Larva (fig.). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii, 22. pl.

Erotylus Boisduvali Chev.

1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Inj. Ins. Ill. 180.

COLYDIIDÆ.

Bothrideres geminatus Say.

1878. Cocoon. Dury. Can. Ent. x. 210.

Erotylathris exaratus Melsh.

1878. Cocoon. Dury. Can. Ent. x. 210.

CUCUJIDÆ.

Silvanus surinamensis Linn.

1839. Larva (fig.). Westwood. Intro. Ins. i. 154.
1842. Larva. Erichson. Wiegem. Archiv. viii. 378.
1846. Larva, pupa (figs.). Curtis. Journ. Roy. Agri. Soc. Eng. pl. 1. 103.
1848. Larva. Erichson. Nat. Ins. Deutschl. iii. 337.
1849. Larva, pupa (fig.). Blisson. Ann. Soc. Ent. Fr. ii. 7. 163-172.
1849. Larva. Coquerel. Ann. Soc. Ent. Fr. ii. 7. 172.
1854. Larva, pupa (figs.). Emmons. Ins. N. Y. 105.
1869. Larva (brief). Packard. Guide. 446.

Silvanus cassiæ Reiche.

1854. Larva (fig., brief). Glover. Rep. U. S. Pat. Off. (Agri) 66. pl. iv (as *S. quadricollis*).
1868. Larva (fig. only). Glover. Rep. U. S. Dept. Agri. 84 (as *S. quadricollis*).

Silvanus bidentatus Fabr.

1868. Larva (habits). Glover. Rep. U. S. Dept. Agri. 84.

Prostomis mandibularis Fabr.

1847. Larva. Erichson. Wiegem. Archiv. xiii. 1. 285.
1854. Larva. Curtis. Trans. Ent. Soc. Lond. 2nd Ser. iii.
1855. Larva. Chapuis et Candeze (quote Erichson). Mem. Soc. Sc. Liege. viii. 425.
1876. Larva. Perris. Ann. Soc. Linn. Lyon. xxii.

Cucujus clavipes Fabr.

1874. Larva (figs.). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 65.
1878. Larva (brief). Wilson. Bull. Bk. Ent. Soc. i. 56.
1886. Larva (brief). Hamilton. Can. Ent. xviii. 27.

Læmophlæus ferrugineus Steph.

1877. Larva. Carpentier. Bull. Soc. Linn. Nord. Fr. Apr. iii. 239.
1877. Larva. Perris. Larves des Coleopt. 575.

CRYPTOPHAGIDÆ.

ANTHEROPHAGUS OCHRACEUS Melsh.

1869. Larva (fig. only). Packard. Guide. 447.

CRYPTOPHAGUS CELLARIS Scop.

1839. Larva (fig.). Westwood. Intro. Ins. i. 148.
1850. Larva, pupa (figs.). Newport. Trans. Linn. Soc Lond. xx. 351. pl. xxxiv.

DERMESTIDÆ.

BYTURUS UNICOLOR Say.

1870. Larva. Fitch. 14th Rep. Nox. Ins. N. Y. 357 (Trans. N. Y. State Agri. Soc.).

DERMESTES VULPINUS Fabr.

1885. Egg, larva, pupa (figs.). Riley. Rep U. S. Dept. Agri. 258-264.
1888. Egg, larva, pupa (figs.). Lintner. 4th Rep. Nox Ins. N. Y. 89.
1889. Egg, larva, pupa (figs.). Jones. Ins. Life. ii. 63.

DERMESTES LARDARIUS Linn.

1667. Larva. Gœdart. Metam. Hist. Nat. Insect.
1688. Larva (fig.). Blankaart. Schow-Burg. der Ruspen. etc. 95. pl. xi.
1700. Larva. Gœdart. Met. Hist. Nat. ii 172. exper. 41.
1720. Larva (fig.). Frisch. Beschreib. all. Ins. pt. 1. 35. pl. x.
1774. Larva, pupa (figs.). De Geer. Mem. iv. Mem. v. 194. pl. vii. figs. 1-9.
1774. Larva. Meineckens. Naturforscher. iii. 55.
1779. Larva. Meineckens. Füssly. Mag. Liebh. Ent. ii. 126.
1792. Larva (brief). Petagne. Instit. Ent. i. 157.
1792. Larva, pupa (figs.). Herbst. Naturg. all. bek. Ins. iv. 118. pl. G.
1804. Larva, pupa. Latreille. Nat. Hist. Ins. & Crust. ix. 238.
1806. Larva (fig. only). Shaw, Gen. Zoo. Ins. 31. pl. vii.
1823. Larva. Latreille. Regne Anim. iii. 362 (1817).
1832. Larva, pupa (figs.). Lyonet. Recherches. 115. pl. xi. figs. 9-13.
1835. Larva. Audouin et Brulle. Hist. Nat. Ins. v. Col. ii. 369.
1837. Larva. Kollar. Nat. Ins. 406.
1839. Larva, pupa (figs.). Westwood. Intro. Ins. i. 158.
1847. Larva (fig.). Sturm. Deutschl. Insect. xix. 65.
1861. Larva, pupa (figs.). Rathvon. Rep. U. S. Dept. Agri. 596.
1867. Larva, pupa (figs.). Mulsant. Hist. Nat. Col. Fr. Scuticollis. pl.
1868. Larva. Healy. Entomologist. vi. 69.
1869. Larva (brief). Walsh & Riley. Am. Nat. ii. 443.
1870. Larva (brief, fig.). Riley. Am. Ent. ii. 308.
1872. Larva, pupa (figs.). Figuier. Ins. World. 475.
1872. Larva. Girard. Ann. Soc. Ent. Fr. v. 2. 302.
1873. Larva (fig., brief). Saunders. Can. Ent. v. 171.
1874. Larva (fig. only). Riley. 6th Rep. Nox. Ins. Ill. 100.
1874 Larva (fig. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 60.
1874. Larva (fig.). Williams. Rep. Ent. Soc. Ont. 26.

1876. Larva (fig. only). Thomas. 1st Rep. Nox. Ins. Ill. 92.
1878. Larva (fig. only). Heustes. Rep. Ent. Soc. Ont. 18.
1878. Larva (fig.). Perkins 5th Rep. Vermont Bd. Agri. 266.
1890. Larva (fig.). Lintner. 6th Rep. Inj. Ins. N. Y. 119-123.

ATTAGENUS PELLIO Linn.

1724. Larva (fig.). Frisch. Beschreib. Ins. v. 23, 24. pl. viii. figs. 1-5.
1774. Larva. De Geer. Mem. iv. mem. v. 199.
1779. Larva. Meinecke. Füssly Mag. Liebh. Ent. ii 126.
1784. Larva. Harrer. Beschreib. Ins. i. 37.
1792. Larva (brief). Petagne. Instit. Ent. i. 157.
1823 Larva. Latreille. Regne Anim. iii 362 (1817).
1835. Larva. Audouin et Brulle. Hist Ins. v. 368.
1839. Larva (brief). Westwood. Int. Ins. i. 159.
1847. Larva, pupa (figs.). Sturm. Deutschl. Insect. xix. 78.
1848. Larva. Erichson. Nat. Ins. Deutschl. iii. 438.
1855. Larva (fig. only). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 441. pl. iii.
1867. Pupa (fig.). Mulsant. Hist. Nat. Col. Fr. Scuticollis 10. pl. i.
1869. Larva (brief). Packard. Guide. 397. fig.
1871. Larva (brief). Bethune (quotes De Geer). Can. Ent. iii. 176.
1872. Larva, pupa (figs.). Figuier. Insect World. 475.

ATTAGENUS PICEUS Oliv.

1847. Larva, pupa (figs.). Sturm. Ins. Deutschl. xix. 78. pl. cccliv.
1861. Larva. Löw. Verh. z. b. Ges. Wien. ii. 293.

TROGODERMA TARSALE Melsh.

1882. Larva, pupa. Snow. Psyche. iii. 352.

TROGODERMA ORNATUM Say.

1883. Larva (brief). Hamilton. Can. Ent. xv. 91.
1884. Larva (Biological notes). Hamilton. Can. Ent. xvi. 133.

ANTHRENUS SCROPHULARIÆ Linn.

1774. Larva (brief). De Geer. Mem. iv. M. v. 121.
1792. Larva (brief). Petagne. Instit. Ent. i. 160.
1797. Larva (brief). Herbst. Natur. System. vii. 328.
1846. Larva (brief). Erichson. Nat. Ins. Deutschl. iii. 454.
1867. Larva (fig.). Mulsant. Nat. Hist. Col. Fr. Scuticollis. pl. ii. fig. 4.
1878. Larva, pupa (figs.). Lintner. Am. Nat. xii. 536.
1878. Larva, pupa (figs.). Lintner. Inj. Ins. 7.
1878. Larva, pupa (figs.). Saunders (quotes Lintner). Rep. Ent. Soc. Ont. 33.
1879. Larva, pupa (figs.). Hagen. Rep. Ent. Soc. Ont. 31.
1880. Larva, pupa (figs.). Anony. Am. Ent. iii. 53.
1882. Larva, pupa (figs.). Lintner. 1st Rep. Inj. Ins. N. Y. 10.
1889. Larva, pupa (figs.). Riley. Insect Life. ii. 127-136.

ANTHRENUS MUSÆORUM Linn.

1774. Larva, pupa (figs.). De Geer. Mem. iv. M. v. 305. pl. viii.
1792. Larva (brief). Petagne. Instit. Ent. i. 157.
1809. Larva (brief) Disderi. Mem. Ac. Sc. Turin. xv. 68.
1816. Larva. Latreille. Nouv. Diet. ii. 161.
1817. Larva, pupa (figs.). Sturm. Ins. Deutschl. ii. 125.
1837. Larva (habits). Kollar. Nat. Schädl. Ins. 403.
1839 Larva (fig.). Westwood. Intro. Ins. i. 160.
1846. Larva. Erichson. Nat. Ins. Deutschl. iii. 458.
1854. Larva, pupa. Letzner. Arb. Schles. Ges. Breslau. 82-84.
1867. Larva. Lucas. Ann. Soc. Ent. Fr. iv. 7. Bull. 25.
1869. Larva, pupa (figs. only). Walsh & Riley. Am. Nat. ii. 443.
1883. Larva (fig. only). Calwer. Kaeferbuch. pl. xlix. fig. 7.

ANTHRENUS VARIUS Fabr.

1846. Larva. Erichson. Ins. Deutschl. iii. 455.
1869. Larva, pupa (fig.). Packard. Guide. 449.

HISTERIDÆ.[1]

HISTER MERDARIUS Hoffm.

1811. Larva (fig.). Paykull. Monog. Hister. 22. pl. i. fig. 1.
1835. Larva. Audouin et Brulle (quotes Paykull). Nat. Hist. Ins. iv. Col. II. 416.
1839. Larva (fig.). Westwood (quotes Paykull). Intro. Ins. i. 182.
1854. Larva, pupa (fig.). Marseul. Ann. Soc. Ent. Fr. iii. 2. 132.
1863. Larva, pupa (fig.). Perris. Hist. Pin. Mar. Col. 132 (1854).

NITIDULIDÆ.

1841. Larvæ. Erichson. Ins. Deutschl. iii. 124.
1869. Larvæ (brief). Packard. Guide. 444.

BRACHYPTERUS URTICÆ Fabr.

1876. Larva, pupa. Perris. Gobert. Catal. iii. 103.
1877. Larva, pupa. Perris. Larves des Col. 37.

CARPOPHILUS HEMIPTERUS Linn.

1868. Larva (fig. only). Glover. Rep. U. S. Dept. Agri. fig. 31.
1877. Larva (fig.), pupa. Perris. Larv. des Col. 45–47.

IPS FASCIATUS Oliv.

1869. Larva (fig. only). Packard. Guide. 444.
1874. Larva (fig. only). Le Baron (after Packard). 4th Rep. Nox. Ins. Ill. 60.
1876. Larva (fig. only). Thomas. 1st Rep. Nox. Ins. Ill. 91 (as *I. 4-signatus*).

LATHRIDIIDÆ.

Lathridius minutus Linn.

1855. Larva (fig.). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 433. pl. ii. fig. 10.
1869. Larva (fig. only). Packard. Guide. 447.

TROGOSITIDÆ.

Tenebrioides mauritanica Linn.

1787. Larva. Dorethes. Mem. Soc. Agri. Paris.
1797. Larva. Herbst. Natursystem. vii. 274.
1803. Larva. Latreille. Hist. Nat. Crust. & Ins. xi. 234.
1807. Larva. Sturm. Ins. Deutsch. ii. 245.
1832. Larva. Hammerschmidt. De Ins. Agri. damn. pl. ii.
1839. Larva (fig.). Westwood. Intro. Ins. i. 147.
1845. Larva. Erichson. Nat. Ins. Deutsch. iii. 244.
1846. Larva (fig.). Curtis. Journ. Roy. Agri. Soc. Eng. pl. i. 106.
1855. Larva. Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 415.
1863. Larva. Perris. Hist. Pin. Marit. i. 86 (1853).
1869. Larva. Glover. Rep. U. S. Dept Agri. 83 (1868).
1877. Larva. Perris. Larv. des Col. 50.

Tenebrioides obscura Horn.

1889. Larva (fig.). Popenoe. The Industrialist. xiv. 153.

Tenebrioides corticalis Melsh.

1870. Larva (fig. only). Glover. Rep. U. S. Dept. Agri. 66.
1874. Larva (fig. only). Le Baron (after Riley). 4th Rep. Inj. Ins. Ill. 64.

Thymalus fulgidus Er.

1890. Larva, pupa. Beutenmüller. Ent. Am. vi. 57.

PARNIDÆ.

Psephenus Lecontei Lec.

1844. Larva (fig.). DeKay. Zoo. New York. pt. vi. Crust. 53. pl. x (as *Fluvicola Herricki*).
1850. Larva (brief). Leconte. Proc. Am. Ass. Adv. Sc. 272.
1850. Larva, pupa. Leconte. Agassiz. Lake Superior. 241.
1852. Larva (brief). Leconte. Pro. Ac. Sc. Phil. vi. 41.
1855. Larva, pupa. Chapuis et Candeze (quote LeConte). Mem. Soc. Sc. Liege. viii. 495.
1869. Larva (fig.). Packard. Guide. 450.
1869. Larva (fig.). Harris. Harr. Corr. 226. pl. iii. fig. 7.
1874. Larva (fig.). Rolph. Wiegem. Archiv. xiv. pt. i. 16–22. pl. i.
1877. Larva (fig. only). Packard. Half Hours Ins. 215.
1880. Larva, pupa (brief). Hubbard. Am. Ent. iii. 73.
1883. Larva (figs.). Kellicott. Can. Ent. xv. 191.

HELICHUS LITHOPHILUS Germ. (?)

1841. Larva. Erichson. Wiegem. Archiv. 107. pt. I.
1883. Larva (fig. only). Kellicott. Can. Ent. xv. 192.

HELICHUS FASTIGIATUS Say.

1869. Larva (very brief). Leconte. Harr. Corr. 227.

STENELMIS CRENATUS Say.

1869. Larva (very brief). Leconte. Harr. Corr. 227.

DASCILLYDÆ.

PTILODACTYLA SERRICOLLIS Say.

1862. Larva (fig.). O. Sacken. Proc. Ent. Soc. Phil. i. 109. pl. i. fig. 3 (as *P. elaterina*).

PRIONOCYPHON DISCOIDEUS Say.

1862. Larva, pupa. O. Sacken. Proc. Ent. Soc. Ont. i. 115.
1869. Larva, pupa (brief). Packard (quotes O. Sacken). Guide. 464.

CYPHON VARIABILIS Thunb.

1866. Larva, pupa (figs.). Frauenfeld. Verh. z. b. Geo. Wien. xvi. 969.
1867. Larva, pupa. Tournier (quotes Frauenfeld). Assoc. zool. du Leman.
1874. Larva (brief). Rolph. Wiegem. Archiv. 40. pt. I. 25.

RHIPICERIDÆ.

ZENOA PICEA Beauv.

1862. Larva (fig.). O. Sacken. Proc. Ent. Soc. Phil. i. 107. pl. i. fig. 2.

ELATERIDÆ.

1877. Larvæ. Perris. Larv. des Col. 166–169.

FORNAX ORCHESIDES Newm (?)

1861. Larva (very brief). Horn. Proc. Ent. Soc. Phil. i. 43.
1862. Larva, pupa (fig.). O. Sacken. Proc. Ent. Soc. Phil. i. 112.

FORNAX BADIUS Melsh.

1862. Larva, pupa (figs). O. Sacken. Proc. Ent. Soc. Phil. i. 113, 114.

ALAUS OCULATUS Linn.

1841. Larva (brief). Harris. Inj. Ins. Mass. 48.
1854. Larva. Emmons. Ins. N. Y. 87.
1855. Larva (fig.). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 482. pl. v. fig. 3.
1861. Larva (fig.). Rathvon. Rep. U. S. Dept. Agri. 58.
1865. Larva. Thomas. Trans. Ill. Agri. Soc. v. 417.
1868. Larva (fig. only). Glover. Rep. U. S. Dept. Agri. 93.
1869. Larva (fig. only). Harris. Harr. Corr. 139. pl. iv.
1876. Larva (brief). Thomas. 1st Rep. Inj. Ins. Ill. 116.
1879. Larva. Harrington. Rep. Ent. Soc. Ont. 82.

1881. Larva. Saunders. Can. Ent. xiii. 117.
1881. Larva. Saunders. Rep. Ent. Soc. Ont. 21.
1883. Larva (fig.). Saunders. Ins. Inj. Fruit. 26.

ALAUS MYOPS Fabr.

1862. Larva (very brief). Evett. Proc. Ent. Soc. Phil. i. 227.
1868. Larva (habits). Glover (quotes Evett). Rep. U. S. Dept. Agri. 93.
1870. Larva (fig.). Schiœdte. Nat. Tidsskr. vi.

ELATER NIGRICOLLIS Hbst.

1883. Larva. Coquillett. Can. Ent. xiii. 101.

LUDIUS ATTENUATUS Say.

1869. Larva (fig. only). Packard. Guide. 422.

MELANOTUS CASTANIPES Payk.?

1870. Larva, pupa (figs.). Schiœdte. Nat. Tidsskr. vi. pl. vii.

AGRIOTES MANCUS Say.

1872. Larva, pupa (figs.). Pettit. Can. Ent. iv. 3.
1877. Larva, pupa (figs. only). Packard. Half Hours Ins. 26.
1879. Larva, pupa (figs. only). Harrington. Rep. Ent. Soc. Ont. 84.

ATHOUS CUCULLATUS Say.

1883. Larva. Coquillett. Can. Ent. xv. 101.

MELANACTES PICEUS De G. (?)

1874. Larva (fig. only). Le Baron (after Riley). 4th Rep. Inj. Ins. Ill. 45.

UNKNOWN SPECIES.

1868. Luminous Larvæ. Bethune & Morris. Can. Ent. i. 2, 38 (*Melanactes ? ?*).
1875. Luminous Larvæ. Mann. Psyche. i. 89.
1877. Larva (figs.). Packard. Half Hours Ins. 27.
1878. Larva (fig.). Riley. 1st Rep. U. S Ent. Com. 304.
1880. Larva (fig.). Clark. Am. Ent. iii. fig. 108 (as *Melanactes ?*).

BUPRESTIDÆ.

1890. Food-Habits. Blanchard. Ent. Am. v. 29–32.

CHALCOPHORA VIRGINIENSIS Dr.

1858. Larva (brief). Fitch. Rep. Nox. Ins. N. Y. 697–700 (Trans. N. Y. Agri. Soc. 1857).
1882. Larva (fig.). Packard. 3rd Rep. U. S. Ent. Com. 252. pl. vi.

DICERCA DIVARICATA Say.

1829. Larva. Harris. New Eng. Farm. viii. 2.
1869. Larva. Harris. Harr. Corr. 357.
1881. Larva. Packard. Ins. Inj. For. & Sh. Tr. 108.
1882. Larva (fig.). Packard. 3rd Rep. U. S. Ent. Com. 255. pl. vi. fig. 2.
1883. Larva (brief). Saunders. Ins. Inj. Fruit. 200.

DICERCA OBSCURA Fabr. (?)

1829. Larva. Harris. New Eng. Farm. viii. 2.
1869. Larva. Harris. Harr. Corr. 357.
1881. Larva. Packard (quotes Harris). Ins. Inj. For & Sh. Tr. 72 (as *D. lurida*).

MELANOPHILA Sp.

1883. Larva (fig.). Packard. 3rd Rep. U. S. Ent. Com. 253. pls. vi. fig. 4. xii. fig. 1.

CHRYSOBOTHRIS FEMORATA Fabr.

1854. Larva (fig.). Fitch. 1st Rep. Trans. N. Y. Agri. Soc. 731.
1861. Larva. (fig., brief). Rathvon. Rep. U. S. Dept. Agri. 607.
1865. Larva Thomas (quotes Fitch). Trans. Ill. Agri. Soc. v. 420.
1866. Larva (brief). Walsh. Pract. Ent. i. 26.
1869. Larva (fig. only). Packard. Guide. 457.
1874. Egg, Larva, pupa (figs.). Riley. 7th Rep. Nox. Ins. Mo. 72.
1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Nox. Ins Ill. 94.
1874. Larva (brief, figs.). Reed. Rep. Ent. Soc. Ont. 13.
1875. Larva (fig. only). Cook. 12th Rep. Mich. Bd. Agri. 126 (1873).
1876. Larva (fig.). Perkins. 2nd Bi. Rep. Vermont Bd. Agri. 601.
1876. Egg, larva, pupa (figs.). Thomas (quotes Riley). 1st Rep. Nox. Ins. Ill. 110.
1877. Larva (fig.). Packard. Half Hours Ins. 165.
1877. Larva (brief). Bethune. Can. Ent. ix. 224.
1877. Larva, pupa (figs.). Bethune. Rep. Ent. Soc. Ont. 25.
1878. Larva, pupa (figs.). Fletcher. Rep. Ent. Soc. Ont. 49.
1881. Larva, pupa (figs.). Packard. Ins. Inj. For. & Sh. Tr. 18.
1883. Larva, pupa. Packard. 3d Rep. U. S. Ent. Com. 251, 252.
1883. Larva (fig. only). Harrington. Rep. Ent. Soc. Ont. 44.
1887. Larva, pupa (figs.). Harrington. Rep. Ent. Soc. Ont. 31.
1887. Larva, pupa (figs.). Bethune. Rep. Ent. Soc. Ont. 57.

CHRYSOBOTHRIS CHRYSOELA Ill.

1885. Larva. Hubbard. Ins. Aff. Orange. 172.

AGRILUS RUFICOLLIS Fabr.

1870. Larva (fig. only). Glover. Rep. U. S. Dept. Agri. 67.
1870. Larva (fig.). Riley. Am. Ent. ii. 103, 128.
1873. Larva (fig.). Saunders. Rep. Ent. Soc. Ont. 8.
1876. Larva (brief). Thomas. 1st Rep. Nox. Ins. Ill. 114.
1878. Larva (fig. only). Fletcher. Rep. Ent. Soc. Ont. 54.
1880. Larva (fig. only). Fuller. Am. Ent. iii. 91.
1883. Larva (fig.). Saunders. Ins. Inj. Fruit 307.
1890. Habits (fig. of Gall). Lintner. 6th Rep. Inj. Ins. N. Y. 123–125.

BRACHYS ÆRUGINOSA Gory.

1873. Larva (fig.). Packard. 3d Rep Inj. Ins. Mass. 22.
1873. Larva (fig.). Packard. Am Nat. vii. 543.
1881. Larva (fig.). Packard. Ins. Inj. For. & Sh. Tr. 130.

PACHYSCELUS LÆVIGATUS Say.

1873. Larva (fig.). Packard. 3d Rep. Inj. Ins. Mass. 23.
1873. Larva (fig.). Packard. Am. Nat vii. 544.

UNKNOWN SPECIES.

1883. Larva Packard. 3d Rep. U. S. Ent. Com. 255. pl. v. fig. 5.
1883. Larva. Packard. 3d Rep. U. S. Ent. Com. 254 (as *Melanophila?*).

LAMPYRIDÆ.

EROS THORACICUS Rand.

1876. Larva. Moody. Psyche. i. 185.

CÆNIA DIMIDIATA Fabr.

1869. Larva (brief). Packard. Guide. 433.
1886. Larva, pupa (brief). Lugger. Proc. Ent. Soc. Wash. i. 30.

PHOTINUS PYRALIS Linn.

1868. Larva, pupa (figs.). Walsh & Riley. Am Ent. i. 19.
1869. Larva, pupa (figs.). Packard. Guide. 466.
18—. Larva, pupa (figs.). Riley.
1874. Larva, pupa (figs only). Le Baron (after Riley). 4th Rep. Inj. Ins. Ill. 106.

LAMPROHIZA SPLENDIDULA Linn.

1823. Larva. Latreille. Regne Anim. iii. 328 (1817).
1833. Larva (fig.). Villaret. Ann Soc. Ent. Fr. 354. pl. xva.

CALOPTERON RETICULATUM Fabr.

1883. Larva, pupa. Coquillett. Can. Ent. xv. 97.

PHOTURIS PENNSYLVANICA De G.

1869. Larva (brief, fig.). Packard. Guide. 466.
1880. Larva (fig. only). Riley. Am. Ent. iii. 254.

ZARHIPIS RIVERSI Horn.

1886. Larva (brief). Rivers. Bull. Cal. Acad. Sc. ii. 5. 71.
1886. Larva (brief). Rivers. Am. Nat. 648.

CHAULIOGNATHUS PENNSYLVANICUS De G.

1868. Larva (fig.). Walsh. Am. Ent. i. 35.
1872. Larva (fig.). Riley. 4th Rep. Nox. Ins. Mo. 28.
1874. Larva (fig. only). Le Baron. 4th Rep. Inj. Ins. Ill. 108.
1879. Larva (brief, fig.). Comstock. Cotton Insects. 175.

1879. Larva (fig. only). Comstock. Rep. U. S. Dept. Agri. pl. xii. fig. 4.
1880. Larva (fig. only). Riley. Bull. U. S. Ent. Com. No. 3. 35.
1880. Larva (fig.). Hubbard. Am. Ent. iii. 249.
1883. Larva (fig.). Saunders. Ins. Inj. Fruit. 185 (as *C. americanus*).
1884. Larva (fig. only). Cutting. 8th Rep. Vermont Bd. Agri. 252.
1884. Larva (fig. only). Edge. Agri. Penn. 102 (as *C. americanus*).
1885. Egg, young larva (brief), mature larva (fig.). Hubbard. 4th Rep. U. S. Ent. Com. 96.
1888. Larva (fig. only). Lintner. 4th Rep. Inj. Ins. N. Y. 86.

PHENGODES LATICOLLIS Lec.

1887. Egg (brief). Atkinson. Am. Nat. xx. 855.

TELEPHORUS BILINEATUS Say.

1871. Larva (fig. only). Packard. Am. Nat. v. 427.
1872. Larva (fig.). Riley. 4th Rep. Nox. Ins. Mo. 29.
1878. Larva (fig.). Riley. 1st Rep. U. S. Ent. Com. 303.

CLERIDÆ.

ELASMOCERUS TERMINATUS Say.

1886. Pupa. Hamilton. Can. Ent. xviii. 28.

TARSOSTENUS UNIVITTATUS Rossi.

1856. Larva, pupa (figs.). Perris. Mem. Soc. Sc. Liege. x. 238. pl. v.

CLERUS ICHNEUMONEUS Fabr.

1861. Larva, pupa (brief, figs.). Rathvon. Rep. U. S. Dept. Agri. 597.

OPILUS DOMESTICUS Kl.

1837. Larva. Sturm. Nat. Ins. Deutschl. ii. 16.
1855. Larva (fig.). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 506. pl. vi.
1857. Pupa. Letzner. Arb. Schles. Ges. Breslau. 122.
1862. Larva. Dœbner. Berlin. Ent. Zeit. vi. 67.

NECROBIA RUFICOLLIS Fabr.

1839. Larva, pupa (figs). Westwood. Intro. Ins. i. 266.
1848. Larva, pupa (fig.). Heeger. Isis. 974. pl. viii.
1863. Larva, pupa. Mulsant (quotes Heeger). Hist. Nat. Col. Fr. Angusticollis. 119.
1877. Larva, pupa (figs.). Perris. Larves des Col. 208–213.

NECROBIA RUFIPES Fabr.

1874. Egg, larva, pupa, cocoon (figs.). Riley. 6th Rep. Nox. Ins. Mo. 96.
1878. Larva, pupa, cocoon. Perkins (quotes Riley). 5th Rep. Vermont Bd. Agri. 267.

PTINIDÆ.

PTINUS FUR Linn.

1700. Larva. Gœdart. Metam. Nat. ii. 172. exp. 41.

1774. Larva. Meinecke. Naturf. iii. 53.
1748. Larva, pupa (very brief). Linne. Syst. Nat. 1607 (6th Ed.).
1774. Larva, pupa (figs.). De Geer. Mem. iv. M. v. 234. pl. ix.
1776. Larva. Gœze. Naturforsch. viii. 62. pl. ii.
1779. Larva. Meinecke. Füssly Mag. Lieb. Ent. ii. 126.
1792. Larva, pupa (brief). Petagne. Instit. Ent. i. 163.
1803. Larva. Latreille. Hist. Nat. Crust. & Ins. ix. 164.
1823. Larva. Latreille. Regne Anim. iii. 336 (1817).
1836. Larva. Audouin & Brulle. Ann. Soc. Ent. Fr. Bull. v. pl. lxii.
1869. Larva (fig.). Packard. Guide. 470.
1869. Larva (fig. only). Riley. Am. Nat. ii. 443.
1876. Larva. Thomas. 1st Rep. Nox. Ins. Ill. 121.
1883. Larva (fig.). Calwer. Kaferb. 375. pl. xlix.

Ptinus brunneus Duft.

1870. Larva (brief). Shimer. Am. Ent. ii. 323.

Ernobius mollis Linn.

1792. Larva (brief). Petagne. Instit. Ent. i. 162.
1837. Larva (brief). Ratzburg. Forstius. i. 42.
1863. Larva, pupa (figs.). Perris. Hist. Pin. Mar. i. 228–233 (1854).
1869. Larva (fig. only). Packard. Guide. 471.
1877. Larva (brief). Kiesenwetter. Nat. Ins. Deutschl. v. 124.

Xestobium affine Lec.

1881. Larva. Packard. Ins. Inj. For. & Sh. Tr. 109.
1882. Larva (fig.). Packard. 3d Rep. U. S. Ent. Com. pl. xiii. fig. 3.

Sitodrepa panicea Linn.

1721. Larva, pupa (figs.). Frisch. Beschreib. Ins. (as *Anobium*).
1837. Larva (brief). Kollar. Nat. Ins. 396 (as *Anobium*).
1839. Larva (brief). Westwood. Intro. Ins. i. 270 (as *Anobium*).
1854. Larva, pupa (figs.). Glover. Rep. U. S. Pat. Off. (Agri.). 72. pl. v (as *Anobium*).
1861. Larva (notes). Horn. Proc. Ent. Soc. Phil. i. 28 (as *Anobium*).
1863. Larva (brief). Stierlin. Mitth. Schw. Ent. Ges. 119 (as *Anobium*).
1868. Larva, pupa (figs.). Glover. Rep. U. S. Dept. Agri. 98.
1869. Larva. Perris. Ann. Soc. Ent. Fr. iv. 9. 467 (as *Anobium*).
1869. Larva (brief), pupa (fig.). Packard. Guide. 470.
1870. Larva. Dunning. Proc. Ent. Soc. Lond. 33 (as *Anobium*).
1870. Egg, larva (brief). Shimer. Am. Ent. ii. 322.
1876. Larva (brief). Thomas. 1st Rep. Nox. Ins. Ill. 122.

Eucrada humeralis Melsh.

1882. Cocoon. Bowditch. J. Bost. Zoo. Soc. i. 27.

Sinoxylon basilare Say.

1872. Larva, pupa (figs.). Riley. 4th Rep. Nox. Ins. Mo. 53.

1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 103.

1876. Larva, pupa (figs.). Thomas (quotes Riley). 1st Rep. Nox. Ins. Ill. 124.

1878. Larva, pupa (figs.). Perkins (quotes Riley).

1883. Larva, pupa (figs.). Saunders (quotes Riley). Ins. Inj. Fruit. 243.

1885. Larva, pupa (figs.). Lintner. 2d Rep. Nox. Ins. N. Y. 130.

AMPHICERUS BICAUDATUS Say.

1872. Larva (habits). Riley. 4th Rep. Nox. Ins. Mo. 51.

1885. Larva (brief). Lintner. 2d Rep. Nox. Ins. N. Y. 127.

1888 Larva, pupa (brief). Popenoe. The Industrialist. xiii. 181.

DINAPATES WRIGHTII Horn.

1886. Larva (fig.). Horn. Trans. Am. Ent. Soc.

DINODERUS SUBSTRIATUS Payk.

1856. Larva, pupa. Fuss. Verhandl. Siebeub. Ver. Nat. vii. 35-37.

1863. Larva, pupa (figs.). Perris. Hist. Pin. Mar. i. 493-497.

LYCTUS OPACULUS Lec.

1869. Larva, pupa (figs., brief). Packard. Guide. 472.

1885. Larva, pupa (figs. only). Lintner. 2d Rep. Nox. Ins. N Y. 130.

LUCANIDÆ.

LUCANUS DAMA Thunb.

1861. Larva, pupa (figs. brief). Rathvon. Rep. U. S. Agri. 599.

1869. Larva, cocoon. Packard. Guide. 451.

1874. Larva, cocoon (figs. only). Le Baron (after Packard). 4th Rep. Nox. Ins. Ill. 77.

1879. Egg, larva (brief). Fletcher. Rep. Ent. Soc. Ont. 66.

1881. Larva, pupa (brief). Saunders. Rep. Ent. Soc. Ont. 22.

1881. Larva (brief). Saunders. Can. Ent. xiii. 118.

1882. Larva (fig.). Fuchs. Bull. Bk. Ent. Soc. v. 50.

1883. Larva, cocoon (figs.). Saunders. Ins. Inj. Fruit. 24.

DORCUS PARALLELUS Say.

1881. Pupa. Schaupp. Bull. Bk. Ent. Soc. iv. 35.

1882. Pupa (fig.). Schaupp. Bull. Bk. Ent. Soc. v. 18. pl. fig. 7.

1882. Pupa (fig.). Fuchs. Bull. Bk. Ent. Soc. v. 52.

CERUCHUS PICEUS Web.

1882. Larva (fig.), pupa (brief). Fuchs. Bull. Bk. Ent. Soc. v. 59.

PASSALUS CORNUTUS Fabr.

1855. Larva (fig.). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 467. pl. xi.

1861. Larva (fig. only). Rathvon. Rep. U. S. Dept. Agri. 599.

1872. Larva, pupa (figs.). Riley. 4th Rep. Nox. Ins. Mo. 139.

1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 78.

1874. Larva, pupa (figs.). Schiœdte. Nat. Tidsskr. ix. 356. pls. xviii, xix.

1882.* Larva (brief), pupa (fig.). Fuchs. Bull. Bk. Ent. Soc. v. 60.

SCARABIDÆ.

Copris carolina Linn.

1862. Larva (fig.). O. Sacken. Proc. Ent. Soc. Phil. i. 105. pl. i. fig. 1.

1874 Larva, pupa, cocoon (figs.). Le Baron (quotes Riley). 4th Rep. Nox. Ins. Ill. 80.

Onthophagus nuchicornis Linn.

1877. Larva (fig.). Perris. Larves des Col. 109.

Aphodius fossor Linn.

1855. Larva (fig.). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 464. pl. iv.

1869. Larva (fig. only). Packard. Guide. 453.

1874. Larva. Schiœdte. Nat. Tidsskr. iii. 9. 328.

1877. Larva (fig.). Perris. Larves des Col. 109.

Aphodius fimetarius Linn.

1720. Larva, pupa (figs.). Frisch. Beschreib. all. Ins. 35. pl. xix. (Supposed by De Haan Mem. s. l. Met. 23 to be a Staphylinid.)

1842. Larva. Mulsant. Hist. Nat. Col. Fr. Lamell. 159.

1848. Larva. Erichson. Nat. Ins. Deutschl. 806.

Aphodius granarius Linn.

1874. Larva. Schiœdte. Nat. Tidsskr. iii. 9. 327.

Aphodius lividus Oliv.

1834. Larva, pupa (figs.). Bouche. Nat. der Ins. 190. No. 16.

1848. Larva, pupa. Erichson (quotes Bouche). Nat. Ins. Deutsch. iii. 838.

Aphodius inquinatus Hbst.

1842. Larva (fig.). Mulsant. Hist. Nat. Col. Fr. Lamell. pl. i. fig. 89.

Pleocoma sp.

1866. Larva (fig.). O. Sacken. Tran. Am. Ent. Soc. v. 84.

Trox monachus Hbst.

1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 82 (as *T. pustulatus*).

Trox scabrosus Beauv.

1855. Larva (fig.). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 466. pl. iv. fig. 4 (as *T. carolinus*).

1869. Larva (fig. only). Packard. Guide. 454.

MACRODACTYLUS SUBSPINOSUS Fabr.

1841. Egg, larva, pupa (brief). Harris. Inj. Ins. Mass. 33.
1855. Larva, pupa (brief). Fitch. 2d Rep. Nox. Ins. (Tran. N. Y. Agri. Soc. 483).
1861. Larva (fig. only). Rathvon. Rep. U. S. Dept. Agri. 602.
1869. Egg, larva, pupa (brief). Packard. Guide. 454.
1873. Egg, larva, pupa. Riley. 5th Rep. Nox. Ins. Mo. 108.
1876. Egg, larva. Thomas (quotes Harris). 1st. Rep. Nox. Ins. Ill. 103.
1878. Egg, larva (brief). Perkins. 5th Rep. Verm. Bd. Agri. 284.
1883. Egg, larva, pupa. Saunders (quotes Harris). Ins. Inj. Fruit. 281.
1890. Egg, larva, pupa (figs.). Riley. Insect Life. ii. 295.

LACHNOSTERNA FUSCA Fröhl.

1841. Larva (brief). Harris. Inj. Ins. Mass. 28 (as *Phyllophaga quercina*).
1861. Larva (fig. only.). Rathvon. Rep. U. S. Dept. Agri. 601.
1866. Larva (brief). Walsh. Pract. Ent. i. 60 (as *L. quercina*).
1869. Larva (fig. only). Packard. Guide. 455.
1869. Pupa (fig. only). Riley. Am. Nat. ii. 192.
1872. Larva, pupa (figs. only). Packard. 3d Rep. Inj. & Ben. Ins. Mass.
1873. Larva, pupa (figs. only). Packard. Am. Nat. vii. 530.
1874. Larva, pupa (figs., brief). Geddes. Can. Ent. vi. 68 (as *L. quercina*).
1874. Larva, pupa (figs. only). Le Baron. 4th Rep. Nox. Ins. Ill. 85.
1875. Larva, pupa (figs.). Cook. 12th Rep. Bd. Agri. Mich. 112.
1876. Larva, pupa (figs.). Thomas. 1st Rep. Nox. Ins. Ill 97.
1877. Larva, pupa (fig. only). Gott. Rep. Ent. Soc. Ont. 43 (as *P. quercina*).
1877. Larva, pupa (figs. only). Thomas. 7th Rep. Nox. Ins. Ill. 33.
1877. Larva, pupa (figs. only). Packard. Half Hours Ins. 89.
1879. Larva, pupa (figs. only). Fletcher. Rep. Ent. Soc. Ont. 69.
1879. Larva (brief). Howard. Rep. Ent. Soc. Ont. 35.
1880. Larva, pupa (figs. only). Packard. Zoology. 372 (2d Ed.).
1883. Larva, pupa (figs. only). Forbes. Tr. Wis. Hort. Soc. xiii. 37.
1883. Larva (fig.), pupa (brief). Saunders. Ins. Inj. Fruit. 213.
1883. Larva, pupa (figs. only). Harrington. Rep. Ent. Soc. Ont. 42.
1884. Larva, pupa (figs. only). Forbes. 2nd Rep. Nox. Ins. Ill. 144 (1883).
1884. Larva, pupa (figs. only). Edge. Agri. Penn. 37.
1885. Larva, pupa (figs. only). Fletcher. Rep. Ent. Soc. Ont. 49.
1888. Egg, larva, pupa (figs.). Lintner. Bull. No. 5. N. Y. State Mus. Nat. Hist. 5.
1890. Larva, pupa (figs.). Weed. Bull. Ohio Exp. St. i. 133.

POLYPHYLLA 10-LINEATA Say.

1888. Larva (fig.). Horn. Trans. Am. Ent. Soc. xv. 21. pl. iii. fig.

PELIDNOTA PUNCTATA Linn.

1855. Larva (fig.). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 460. pl. iv.

1870. Larva, pupa (figs.). Riley. Am. Ent. ii. 295.
1871. Larva, pupa (figs.). Riley. 3rd Rep. Nox. Ins. Mo. 77-79.
1874. Larva, pupa (figs. only). Le Baron (quotes Riley). 4th Rep. Nox. Ins. Ill. 88.
1874. Larva, pupa (figs.). Saunders. (quotes Riley). Can. Ent. vi. 141.
1876. Larva, pupa (figs.). Thomas. 1st Rep. Nox. Ins. Ill. 106.
1877. Larva, pupa (figs. only). Gott. Rep. Ent. Soc. Ont. 45.
1878. Larva, pupa (figs.). Perkins. 5th Rep. Verm. Bd. Agri. 283.
1879. Larva, pupa (figs.). Fletcher. Rep. Ent. Soc. Ont. 69.
1883. Larva, pupa (figs.). Saunders. Ins. Inj. Fruit. 277.

COTALPA LANIGERA Linn.

1869. Egg, young larva (brief), mature larva (fig.). Lockwood. Am. Nat. ii. 186.
1869. Egg, larva, pupa (fig., brief). Packard (quotes Lockwood). Guide. 455.
1872. Larva (fig.). Packard. 3rd Rep. Nox. Ins. Mass. 244.
1873. Egg, larva (fig.). Packard. Am. Nat. vii. 531.
1877. Larva (fig.). Packard Half Hours Ins. 32.
1879. Larva (brief). Fletcher. Rep. Ent. Soc. Ont. 70.
1879. Egg, larva (fig.). Saunders. Can. Ent. xi. 22.
1883. Larva (fig.). Forbes. Trans. Wisc. Hort. Soc. xiii. 39.
1883. Egg, larva (figs.). Saunders. Ins. Inj. Fruit. 155.
1884. Egg, larva (fig.). Forbes. 2nd Rep. Nox. & Ben. Ins. Ill. 146.

CHALEPUS TRACHYPYGUS Burm.

1882. Larva (fig.). Riley. Rep. U. S. Dept. Agri. 129. pl. vi. fig. 5.

LIGYRUS RELICTUS Say.

1880. Larva (brief). Lintner. Bull. 5th N. Y. St. Mus. Nat. Hist. 6.

LIGYRUS RUGICEPS Lec.

1888. Young larva (brief). Howard. Ins. Life. i. 11.

XYLORYCTES SATYRUS Fabr.

1863. Larva (brief). Walsh. Proc. Bost. Soc. Nat. Hist. ix. 287.
1868. Larva (brief). Anony. Am. Nat. i. 60.
1873. Larva (brief). Glover. Rep. U. S. Dept. Agri. 152.

STRATEGUS JULIANUS Burm.

1886. Larva, pupa (figs.). Duges. Ann. Ent. Soc. Belg. xxx. 27. pl. i.

ALLORHINA NITIDA Linn.

1861. Larva (fig.). Rathvon. Rep. U. S. Dept. Agri. 602.
1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 89.
1876. Larva, pupa (figs. only). Thomas. 1st Rep. Nox. Ins. Ill. 107.
1884. Larva, pupa (figs. only). Forbes. 2nd Rep. Nox. Ins. Ill. 149. pl. vii.
1884. Larva, pupa (figs.). Forbes (after Riley). Miss. Vall. Hort. Soc. ii. 245.

OSMODERMA SCABRA Beauv.

1841. Larva (brief). Harris. Inj. Ins. Mass. 39.
1861. Larva, cocoon (brief). Harris. Ins. Mass. 42.
1869. Larva, cocoon. Packard (quotes Harris). Guide. 457.
1879. Cocoon. Schaupp. Bull. Bk. Ent. Soc. ii. 98.
1883. Larva (brief). Harrington. Rep. Ent. Soc. Ont. 44.
1883. Larva, cocoon (brief). Saunders. Ins. Inj. Fruit. 26.
1889. Larva. Beutenmüller. Psyche. v. p.

VALGUS SQUAMIGER Beauv.

1858. Larva (Biol. notes). Fitch. 4th Rep. Nox. Ins. N. Y. 695 (Trans. N. Y. Agri. Soc. 1857, as *V. Seticollis* Beauv.).

SPONDYLIDÆ.

1862. Larva (fig.). O. Sacken. Pro. Ent. Soc. Phil. i. 118. pl. i. fig. 6.
1869. Larva (fig.). Packard. Guide. 494.

CERAMBYCIDÆ.

1880. Food-Habits. Riley. Am. Ent. iii. 237-239, 270, 271.

CRIOCEPHALUS AGRESTIS Kby.

1882. Pupa (fig.). Packard. 3rd Rep. U. S. Ent. Com. pl. vii. fig. 3.

ORTHOSOMA BRUNNEUM Forst.

1861. Larva (fig. only). Rathvon. Rep. U. S. Dept. Agri. 611 (as *P. cylindricus*).
1869. Larva (fig. only). Packard. Guide. 495 (as *O. unicolor*).
1877. Larva (brief). Bethune. Can. Ent. ix. 221.
1877. Larva (figs. only). Packard. Half Hours Ins. 236.
1881. Larva, pupa. Packard. Ins. Inj. For. & Sh. Tr. 161.
1882. Larva (fig.). Packard. 3d Rep. U. S. Ent. Com. 260. pl. x. fig. 1.
1883. Larva (brief). Saunders. Rep. Ent. Soc. Ont. 54.

PRIONUS LATICOLLIS Dr.

1861. Larva (fig. only). Rathvon. Rep. U. S. Dept. Agri. 612.
1869. Larva, pupa (figs.). Walsh & Riley. Am. Ent. i. 231.
1870. Larva, pupa (figs.). Riley. 2nd Rep. Nox. Ins. Mo. 87.
1873. Larva (fig.). Smith. 6th Rep. Conn. Bd. Agri. 346 (as *P. brevicornis*).
1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th. Rep. Nox. Ins. Ill. 151.
1875. Larva (fig. only). Saunders. Can. Ent. vi. 29.
1875. Larva (fig. only). Saunders. Rep. Ent. Soc. Ont. 39.
1876. Larva (brief). Thomas. 1st Rep. Nox. Ins. Ill. 147.
1877. Larva (fig. only). Bethune. Rep. Ent. Soc. Ont. 23.
1877. Larva (fig. only). Packard. Half Hours Ins. 237.
1877. Larva (fig. only). Cook. 16th Rep. Mich. Bd. Agri.
1878. Larva (fig.). Perkins. 5th Rep. Verm. Bd. Agri. 271.

1881. Larva (fig.). Goldsmith (quotes Riley). Ky. Bureau Agri. 254.
1881. Larva, pupa (figs. only). Packard. Ins. Inj. For. & Sh. Tr. 119.
1883. Larva, pupa (figs.). Saunders. Ins. Inj. Fruit. 232.

Asemum mœstum Hald.

1869. Larva, pupa (figs.). Packard. Guide. 496.
1881. Larva, pupa (figs.). Packard. Ins. Inj. For. & Sh. Tr. 158.
1882. Larva, pupa (figs.). Packard. 3rd. Rep. U. S. Ent. Com. 256. pl. ix.

Hylotrupes bajulus Linn.

1848. Larva (biological notes). Nordlinger. ix. 256.
1857. Larva, pupa (figs.). Heeger. Sitzb. Wien. Acad. Wiss. xxiv. 323.
1863. Larva, pupa (figs.). Perris. Hist. Pin. Mar. i. 368-373.
1875. Larva, pupa (fig.). Schiœdte. Nat. Tidsskr. x. 417. pl. xv.

Phymatodes amœnus Say.

1871. Larva (fig.). Packard. 1st. Rep. Inj. Ins. Mass. 17 (as *callidium*).
1871. Larva (fig.). Packard. Am. Nat. v. 423 (as *callidium*).
1876. Larva (brief) Thomas. 1st Rep. Nox. Ins. Ill. 149. (as *callidium*).
1881. Larva, pupa (fig.). Packard. Ins. Inj. For. & Sh. Tr. 25.

Callidium antennatum Newm.

1861. Larva (fig.). Rathvon. Rep. U. S. Pat. Off. (Agri.). 616 (as *C. violæ*).

Chion cinctus Dr.

1888. Egg, larva, pupa (figs.). Osborn. Gard. & Forest. i. 148.

Elaphidion villosum Fabr.

1819. Larva. Harris. Agri. Reposit. v. 307 (as *Stenocerus putator*).
1826. Larva. Peck. Zoo. Journ. ii. 489 (as *Stenocerus putator*).
1854. Larva (brief). Emmons. Ins. N. York. 124
1858. Larva, pupa. Fitch. 5th Rep. Nox. Ins. 801 (Tr. N. Y. Agri. Soc.).
1862 Larva, pupa (brief). Harris. Inj. Ins. Mass. 98.
1869. Larva, pupa (figs. only). Packard. Guide. 496 (as *S. putator*).
1872. Larva (fig.). Glover. Rep. U. S. Dept. Agri. 72 (1871).
1877. Larva, pupa (fig.). Packard (quotes Fitch) Half Hours Ins. 241 (as *S. putator*).
1878. Larva, pupa (figs.). Buckhaut. Agricul. Penn. 258.
1881. Larva, pupa (fig.). Packard. Ins. Inj. For. & Sh. Tr. 33.
1883. Larva, pupa (fig.). Saunders. Ins. Inj. Fruit. 32.
1884. Larva, pupa (figs.). Edge. Agricul. Penn. 107.

Elaphidion parallelum Newm.

1874. Larva, pupa (figs.). Le Baron (after Reilly). 4th Rep. Nox. Ins. Ill. 152.

1875. Larva, pupa (figs. only). Cook. 12th Rep. Mich. Bd. Agri. 128 (1873–74).
1876. Larva, pupa (figs. only). Thomas. 1st Rep. Nox. Ins. Ill.
1882. Larva (fig.). Packard. 3rd Rep. U. S. Ent. Com. 257. pl. vii. fig. 1.
1883. Larva, pupa (figs.). Saunders. Ins. Inj. Fruit. 33.
1885. Larva, pupa (figs.). Hubbard. Ins. Aff. Orange. 126, 171.

ELAPHIDION INERME Newm.

1885. Larva. Hubbard. Ins. Aff. Fruit. 171.

TRAGIDION FULVIPENNE Say.

1889. Egg. Popenoe. Insect Life. ii. 197.

CYLLENE PICTUS Dr.

1862. Larva, pupa (fig.). O. Sacken. Pro. Ent. Soc. Phil. i. 121. pl. i. (might be *C. robiniæ*).
1869. Larva, pupa (figs.). Packard. Guide. 497.
1881. Larva, pupa (figs.). Packard. Ins. Inj. For. & Sh. Tr. 70.

CYLLENE ROBINIÆ Forst.

1861. Larva, pupa (figs.). Rathvon. Rep. U. S. Pat. Off. (Agri.) 616.
1877. Larva (brief). Bethune. Can. Ent. ix. 223.
1881. Larva, pupa. Packard. Ins. Inj. For. & Sh. Tr. 97.

CYLLENE ERYTHROPTERUS Chev.

1885. Larva, pupa (figs.). Duges. Ann. Ent. Soc. Belg. xxix. 40. pl. iii.

GLYCOBIUS SPECIOSUS Say.

1884. Young larva (brief). Packard. Am. Nat. xviii. 1151.

XYLOTRECHUS COLONUS Fabr.

1881. Larva, pupa. Packard. Ins. Inj. For. & Sh. Tr. 27.
1882. Larva, pupa (fig.). Packard. 3rd Rep. U. S. Ent. Com. 258. pl. xii.
1888. Larva (fig. only). Lintner (after Packard). 4th Rep. Inj. Ins. N. Y. 94.

XYLOTRECHUS ANNOSUS Say.

1883. Larva (biol. notes). Coquillett. Can. Ent. xv. 31.

RHAGIUM LINEATUM Oliv.

1861. Larva (fig.). Rathvon. Rep. U. S. Pat. Off. (Agri.) 620.
1881. Larva. Packard. Ins. Inj. For. & Sh. Tr. 163.
1882. Larva (fig.). Packard. 3rd. Rep. U. S. Ent. Com. 259. pl. xi.

MONOHAMMUS TITILLATOR Fabr.

1858. Larva (brief). Fitch. 4th. Rep. Nox. Ins. 707 (Trans. N. Y. Agri. Soc. 1858, as *M. notatus* Dr.).
1861. Larva, pupa (figs.). Rathvon. Rep. U. S. Pat. Off. (Agri.) 614.

MONOHAMMUS CONFUSOR Kby.

1877. Larva (brief). Bethune. Can. Ent. ix. 225.
1881. Larva, pupa (figs.). Packard. Ins. Inj. For. & Sh. Tr. 154.
1883. Larva (brief). Saunders. Rep. Ent. Soc. Ont. 53.
1884. Egg, young larva (brief). Packard. Am. Nat. xviii. 1150.

MONOHAMMUS SCUTELLATUS Say.

1877. Larva, pupa (brief). Bethune. Rep. Ent. Soc. Ont. 23.
1883. Larva (brief). Saunders. Rep. Ent. Soc. Ont. 53.

GOES TIGRINA De G.

1855. Larva, pupa (fig.). Fitch. Trans. N. Y. Agri. Soc. 853 (1854). (as *Monohanus tigrinus*).

PSENOCERUS SUPERNOTATUS Say.

1862. Larva. O. Sacken. Proc. Ent. Soc. Phil. i. 122.
1869. Larva (fig.). Packard. Guide. 499–500.
1877. Larva (fig.). Packard. Half Hours Ins. 166.
1880. Larva (brief). Saunders. Can. Ent. xii. 6.
1883. Larva (brief). Saunders. Ins. Inj. Fruit. 338.

LEPTOSTYLUS BIUSTUS Lec.

1885. Larva (brief). Ins. Inj. Orange. 174.

LIOPUS FASCICULARIS Harr.

1869. Larva (brief). Packard. Guide. 497.
1871. Larva, pupa (fig.). Packard. 1st Rep. Inj. Ins. Mass. 15–17 (as *L. xanthoxyli*).
1871. Larva, pupa (fig. only). Packard. Am. Nat. v. 424.
1877. Larva (fig. only). Packard. Half Hours Ins. 169, (as *L. xanthoxyli*).
1881. Larva (fig.), pupa. Packard. Ins. Inj. For. & Sh. Tr. 252.

UROGRAPHIS FASCIATUS De G.

1858. Larva. Fitch. 5th. Rep. Trans. N. Y. Agri. Soc. 795.
1881. Larva. Packard. Ins. Inj. For. & Sh. Tr. 22.

ONCIDERES CINGULATA Say.

1880. Larva, pupa (figs.). Riley. Am. Ent. iii. 297.
1885. Egg, larva, pupa (figs., brief). Hubbard. Ins. Inj. Orange. 128.

SAPERDA CALCARATA Say.

1841. Larva (brief). Harris. Inj. Ins. Mass. 88.
1854. Larva (brief). Emmons. Ins. N. Y. 121.
1877. Larva (fig. only). Packard. Half Hours Ins. 251.
1881. Larva (fig.). Packard. Ins. Inj. For. & Sh. Tr. 118.
1889. Larva (fig.). Lugger (after Packard). Bull. No. 9. Minn. Exp. St. 55, 56.

SAPERDA MŒSTA Lec.

1874. Larva, pupa. Saunders. Can. Ent. vi. 60–63.
1881. Larva, pupa. Packard (quotes Saunders). Ins. Inj. For. & Sh. Tr. 118.

SAPERDA CANDIDA Fabr.

1841. Larva (brief). Harris. Inj. Ins. Mass. 89 (as *S. bivittata*).
1855. Larva (fig.). Fitch. Trans. N. Y. St. Agri. Soc. 721 (1854).
1860. Larva. Uhler. Rep. U. S. Pat. Off. (Agri.). 317.
1861. Larva (fig. only). Rathvon. Rep. U. S. Pat. Off. (Agri.) 617. (as *S. bivittata*).
1862. Larva (fig.). Couper. Can. Nat. and Geo. vii. 280.
1862. Larva. Packard. 2nd Rep. Nat. Hist. Soc. Me. 192. (7th Rep. Agri. Me.).
1862. Larva (fig.). Harris. Inj. Ins. Mass. 108. pl. ii. fig. 17.
1869. Larva (fig.). Packard. Guide. 500.
1872. Larva (fig. only). Tenney. Nat. Hist. Anim. 166.
1873. Larva (fig. only). Smith. 6th Rep. Conn. Bd. Agri. 348 (1872–73).
1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 157.
1875. Larva, pupa (figs.). Cook (after Riley). 12th Rep. Mich. Bd. Agri. 124 (1873).
1876. Larva, pupa (figs. only). Thomas (after Riley). 1st. Rep. Nox. Ins. Ill. 153.
1876. Larva, pupa (figs.). Perkins (after Riley). 2d Bi-Rep. Vermont Bd. Agri. 599.
1877. Larva, pupa (figs. only). Half Hours Ins. 164.
1877. Larva (brief). Bethune. Can. Ent. ix. 223.
1877. Larva, pupa (figs.). Bethune. Rep. Ent. Soc. Ont. 27.
1883. Larva, pupa (figs. only). Harrington. Rep. Ent. Soc. Ont. 45.
1883. Egg, larva, pupa (figs.). Saunders. Ins. Inj. Fruit. 17, 18.
1887. Larva, pupa (figs.). Bethune. Rep. Ent. Soc. Ont. 58.

SAPERDA VESTITA Say.

1861. Larva (fig. only). Rathvon. Rep. U. S. Pat. Off. (Agri.). 618.
1877. Larva (fig. only). Packard. Half Hours Ins. 250.
1881. Larva (fig. only). Packard. Ins. Inj. For. & Sh. Tr. 124.

SAPERDA TRIDENTATA Oliv.

1858. Larva. Fitch. 5th Rep. Trans. N. Y. Agri. Soc. 840.
1869. Larva (fig.). Packard. Guide. 499.

1876. Larva (brief). Thomas. 1st Rep. Nox. Ins. Ill. 156.
1877. Larva (fig. only). Packard. Half Hours Ins. 249.
1881. Larva. Packard. Ins. Inj. For. & Sh. Tr. 58.
1882 Larva. Packard. 3d Rep. U. S. Ent. Com. pl. viii. fig. 2.
1885. Larva. Forbes. 3d Rep. Nox. Ins. Ill. 112–114 (1884).
1887. Larva (brief). Harrington. Rep. Ent. Soc. Ont. 31.

SAPERDA FAYI Bland.

1878. Biological Notes. Zimmerman. Can. Ent. x. 220.
1888. Larva, pupa (biological notes). Hamilton. Can. Ent. xx. 6.
1888. Larva, pupa (biological notes). Hamilton. Rep. Ent. Soc. Ont. 41 (1887).

SAPERDA CONCOLOR Lec.

1888. Larva (biolog. notes). Hamilton. Can. Ent. xx. 8.
1888. Larva (biolog. notes). Hamilton. Rep. Ent. Soc Ont. 42 (1887).
1889. Larva (fig., gall-like swelling). Lugger. Bull. No. 9. Minn. Exp. St. 56, 57.

SAPERDA sp.

1882. Larva (fig.). Packard. 3d Rep. U. S. Ent. Com. 256. pl. xii. fig. 4.

OBEREA TRIPUNCTATA Swed.

1841. Larva (brief). Harris. Inj. Ins. Mass. 91.
1854. Larva (brief). Emmons. Ins. N. York. 122.
1861. Larva (fig.). Rathvon. Rep. U. S. Pat. Off. (Agri.). 619.
1873. Egg, larva (brief). Saunders. Rep. Ent. Soc. Ont. 9.
1877. Egg, larva (brief). Bethune. Can. Ent. ix. 226.

UNKNOWN SPECIES.

1882. Larvæ and pupa. Packard. 3d Rep. U. S. Ent. Com. 15 unidentified species are described and figured in this work.

CHRYSOMELIDÆ.

1890. Food-Habits. Beutenmüller. Ent. Am. vi. 175–178.

LEMA COLLARIS Say.

1883. Larva. Coquillett. Can. Ent. xv. 22.

LEMA TRILINEATA Oliv.

1841. Egg, larva (brief). Harris. Inj. Ins. Mass. 96.
1862. Egg, larva, pupa (brief). Harris. Inj. Ins. Mass. 119.
1865. Larva. Thomas. Trans. Ill. Agri. Soc. v. 431.
1866. Egg, larva (brief). Walsh. Pract. Ent. ii. 26.
1868. Egg, larva (fig.), pupa (brief). Walsh & Riley. Am. Ent. i. 26.
1869. Egg, larva, pupa (figs., brief). Packard. Guide. 503.
1870. Egg, larva, pupa (figs.). Compton. Prize Ess. of the Cult. of the Potato. 22.
1871. Egg, larva, pupa (figs.). Riley. Am. Ent. ii. 327.

1871. Egg, larva, pupa (figs.). Saunders. Can. Ent. iii. 43.
1871. Egg, larva, pupa (figs.). Glover. Rep. U. S. Dept. Agri. 74.
1874. Egg, larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 164.
1876. Egg, larva, pupa (figs.). Perkins. 3d Bi-Rep. Verm. Bd. Agri. 573.
1876. Egg, larva, pupa. Thomas. 1st Rep. Nox. Ins. Ill. 159.
1879. Egg, larva, pupa (figs.). Comstock. Rep. U. S. Dept. Agri. 214. pl. iii.
1882. Larva, pupa (figs.). Harrington. Rep. Ent. Soc. Ont. 55.
1885. Egg, larva, pupa (figs.). Lintner. 2d Rep. Nox. Ins. N. Y. 133, 134.

CRIOCERIS ASPARAGI Linn.

1720. Larva, pupa (figs.). Frisch. Beschreib. Ins. i. 27–30. pl. vi. figs. 1–3.
1749. Larva, pupa (figs.). Rösel. Ins. Belust. ii. 11, 12. pl. vi.
1834. Larva (figs.). Bouche. Nat. Ins. 204. pl. x. figs. 38–42.
1839. Egg, larva, pupa (figs.). Westwood. Intro. Ins. i. 374.
1841. Egg, larva. Harris. Inj. Ins. Mass. 96.
1862. Egg, larva, pupa (figs.) Fitch. 8th Rep. Nox. Ins. Trans. N. Y. Agri. Soc. 664–667.
1857. Larva, pupa (detailed). Letzner. Arb. Schles. Geschell. 119.
1873. Egg (brief). Smith. 6th Rep. Conn. Bd. Agri. 349 (1872–73).
1879. Egg, larva (figs.). Comstock. Rep. U. S. Dept. Agri. 216. pl. iii.
1880. Egg, larva (figs. only). Bethune. Rep. Ent. Soc. Ont. 47.
1880. Egg, larva (fig. only). Fuller. Am. Ent. iii. 3.
1880. Egg, larva (figs.). Omerod. Inj. Ins. p.
1881. Egg, larva (figs. only). Bethune. Can. Ent. xiii. 253.
1881. Egg, larva (figs. only). Bethune. Rep. Ent. Soc. Ont. 36.
1882. Egg, larva (figs.). Harrington. Rep. Ent. Soc. Ont. 55.
1882. Egg, larva (figs.). Lintner. 1st. Rep. Nox. Ins. N. Y. 241, 242.
1884. Larva (fig.). Edge. Agri. Penn. 101.

CRIOCERIS 12-PUNCTATUS Linn.

1738. Larva (fig.). Frisch. Beschreib. Ins. xiii. 29, 30. pl. xxviii.

COSCINOPTERA DOMINICANA Fabr.

1869. Larval case. Harris. Harr. Corr. 76.
1874. Egg, larva, case (figs.). Riley. 6th Rep. Nox. Ins. Mo. 127 (1873).
1874. Egg, larva, case (figs.). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 169.
1880. Egg, larva (fig. only). W. S. B. Am. Ent. iii. 227.
1882. Egg, larva (figs. only). Harrington (after Riley). Rep. Ent. Soc. Ont. 55.

CHLAMYS PLICATA Fabr.

1869. Larva, case (figs). Packard. Guide. 507.
1874. Larva, case (figs.). Riley (after Packard). 6th Rep. Nox. Ins. Mo. 128.
1877. Larva, case (fig. only). Packard. Half Hours Ins. 211 (as *Chlamys* sp.).
1882. Larva, case (figs. only). Harrington (after Packard). Rep. Ent. Soc. Ont. 56.

1888. Egg, larva, pupa (figs.). Marlatt. The Industrialist. xiv. 53.

ADOXUS VITIS Linn.

1803. Larva. Latreille. Nat. Hist. Crust. & Ins. xi. 331.
1846. Larva (notes). Guerin-Meneville. Ann. Soc. Ent. Fr. ii. 4 Bull. 35.
1873. Larva (fig.). Von Horvath. Verh. z. b. Ges. Wien. xxiii. 37–40. pl. xviii.
1874. Larva (notes). Girard. Ann. Soc. Ent. Fr. v. 4 Bull. 63. 1140.
1875. Larva. Lichtenstein. Ann. Soc. Ent. Fr. v. 5 Bull. 105.
1879. Life-history. Lichtenstein. Etudes sur le Griboure, Montpellier. 12.

METACHROMA PALLIDA Say.

1883. Larva. Coquillett. Can. Ent. xv. 21 (as *Chrysomela pallida*).

PARIA ATERRIMA Oliv.

1880. Larva, pupa. Cook. 19th Rep. Mich. Bd. Agri. 274.
1880. Larva, pupa, cocoon. Riley. Am. Ent. iii. 243.
1883. Larva (fig.). Forbes. Trans. Wis. Hort. Soc. xiii. 41.
1884. Larva (fig.). Forbes. 2d Rep. Nox. Ins. Ill. 159. pl. ix. fig. 5*b*.
1884. Larva, pupa (fig.). Forbes. Miss. Vall. Hort. Soc. ii. 249.
1884. Larva, pupa (figs.). Forbes. Psyche. iv. 126. pl. i.

GRAPHOPS PUBESCENS Melsh.

1884. Larva, pupa (fig.). Forbes. Trans. Wis. Hort. Soc. xiii. 44 (1883).
1884. Life-history (figs.). Forbes. 2nd Rep. Nox. Ins. Ill. 163. pls. vii, xix (1883).
1884. Larva, pupa (fig.). Forbes. Miss. Vall. Hort. Soc. ii. 246.
1885. Larva, pupa (figs.). Forbes. 3rd Rep. Nox. Ins. Ill. pl. xi. figs. 1, 2, 3 (1884).

COLASPIS BRUNNEA Fabr.

1871. Larva (fig.). Riley. 3rd Rep. Nox. Ins. Mo. 81–84 (as *C. flavida*).
1872. Larva (fig.). Riley. 4th Rep. Nox. Ins. Mo. 34 (as *C. flavida*).
1872. Larva (fig.). Riley. Am. Nat. vi. 293 (as *C. flavida*).
1876. Larva. Thomas (quotes Riley). 1st Rep. Nox. Ins. Ill. 164 (as *C. flavida*).
1880. Larva (fig. only). Anony. Am. Ent. iii. 243.
1882. Larva (fig. only). Harrington. Rep. Ent. Soc. Ont. 57 (as *C. flavida*).
1883. Larva (fig.), pupa (brief). Saunders. Ins. Inj. Fruit. 283.
1884. Larva (fig.). Forbes. 2nd Rep. Nox. Ins. Ill. 156. pl. ix.
1884. Larva, pupa (figs.). Forbes. Psyche. iv. 123. pl. i.
1884. Larva, pupa (figs.). Forbes. Miss. Vall. Hort. Soc. ii. 246.

DORYPHORA CLIVICOLLIS Kby.

1841. Larva, pupa (very brief). Harris. Inj. Ins. Mass. 107 (as *Chrysomela trimaculata*).
1861. Larva (brief). Proc. Ent. Soc. Phil. i. 44 (as *D. trimaculata*).
1869. Larva (fig. only). Packard. Guide. 508 (as *Chry. trimaculata*).
1883. Larva. Coquillett. Can. Ent. xv. 21.

1885. Larva, pupa. French. Can. Ent. xvii. 19.

DORYPHORA II-LINEATA Stål.

1884. Larva, pupa (figs.). Duges. Ann. Ent. Soc. Belg. xxviii. 1. pl. i. figs. 1–14.

DORYPHORA IO-LINEATA Say.

1863. Egg, larva. Fitch. 9th Rep. Nox. Ins. Trans. N.Y. Agri. Soc. 788.
1864. Larva. Thomas. Tran. Ill. Agri. Soc. v. 437.
1865. Larva (brief). Walsh. Pract. Ent. i. 3.
1866. Egg, larva (figs. only). Walsh. Pract. Ent. ii. 13.
1866. Egg, larva (brief). Shimer. Pract. Ent. i. 84.
1867. Larva (fig. only). Glover. Rep. U. S. Dept. Agri. 63.
1868. Egg, larva, pupa (figs.). Walsh & Riley. Am. Ent. i. 41.
1869. Egg, larva, pupa (figs). Packard. Guide. 506.
1870. Egg, larva, pupa (figs.). Compton. Prize Essay of Cult. Potatoe. 23.
1870. Egg, larva, pupa (figs. only). Shimer. Am. Nat. iii. 92.
1871. Egg, larva, pupa (figs., brief). Saunders & Reed. Can. Ent. iii. 42.
1871. Larva (fig., brief). Glover. Rep. U. S. Dept. Agri. 74 (1870).
1874. Egg, larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 165.
1875. Larva (fig. only). Glover. Rep. U. S. Dept. Agric. 123 (1874).
1875. Egg, larva, pupa (figs.). Cook. 12th Rep. Bd. Agri. Mich. 107 (1873).
1875. Egg, larva, pupa (figs. only). Saunders. Rep. Ent. Soc. Ont. 34.
1876. Larva. Thomas. 1st Rep. Nox. Ins. Ill. 161.
1876. Egg, larva, pupa (figs.). Perkins. 3rd Bi. Rep. Verm. Bd. Agri. 578.
1875. Egg, larva, pupa (figs.). Cutting. 2nd Bi. Rep. Verm. Bd. Agri. 671.
1877. Larva, pupa (figs. only). Packard. Half Hours Ins. 280
1880. Egg, larva, pupa (figs.). Fuller. Am. Ent. iii. 116.
1882 Egg, larva, pupa (figs. only). Harrington. Rep. Ent. Soc. Ont. 58.
1883. Pupa (notes). Coleman. Quart. Journ. Bost. Zoo. Soc. ii. 31.
1883. Egg, larva (figs. only). Griffith & Henfrey. Microg. Dict. 270.
1883. Larva. Coquillett. Can. Ent. xv. 21.
1885. Egg, larva, pupa (figs.). Fletcher. Rep. Ent. Ex. Farms. 16.

DORYPHORA JUNCTA Germ.

1868. Egg, larva, pupa (figs.). Walsh & Riley. Am. Ent. i. 43.
1869. Egg, larva (figs.). Packard. Guide. 509.
1870. Larva (fig.). Compton (quotes Walsh). Prize Essay on Cult. of Potatoe. 25.
1871. Larva (fig.). Glover. Rep. U. S. Dept. Agri. 74.
1874. Egg, larva (figs. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 165.
1874. Larva (fig.). Glover. Rep. U. S. Dept. Agric. 123.
1876. Larva. Thomas. 1st Rep. Nox. Ins. Ill. 161.
1877. Egg, larva (figs.). Packard. Half Hours Ins. 208.

1880. Egg, larva (figs.). Fuller. Am. Ent. iii. 117.
1883. Larva. Coquillett. Can. Ent. xv. 22.

CHRYSOMELA MULTIGUTTATA Stäl.

1883. Larva. Coquillett. Can. Ent. xv. 22.

CHRYSOMELA SCALARIS Lec.

1841. Larva (brief). Harris. Inj. Ins. Mass. 107.
1881. Egg, larva, pupa. Packard. Ins. Inj. For. & Sh. Tr. 126.

CHRYSOMELA PHILADELPHICA Linn.

1869. Larva (brief, fig.). Packard. Guide. 509.

CHRYSOMELA SIMILIS Rog.

1883. Larva. Coquillett. Can. Ent. xv. 22.

CHRYSOMELA BIGSBYANA Kby.

1883. Larva. Coquillett. Can. Ent. xv. 22.

PRASOCURIS PHELLANDRII Linn.

1850. Larva (biological notes). Boic. Stett. Ent. zeit. ii. 360.
1857. Larva, pupa. Cornelius. Stett. Ent. zeit. xviii. 404.
1857. Larva, pupa. Letzner. Arb. Schles. Geo. Breslau. 127–130.
1866. Larva (biolog. notes). Low. Ver h. z. b. Ges. Wien. xvi. 956.
1874. Larva, pupa. Kaltenbach (quotes Cornelius). Pflanze feinde. 10.

GASTROIDEA POLYGONI Linn.

1854. Larva, pupa (figs.). Heeger. Sitzb. Ak. Wiss. Wien. xi. 927–929.
1855. Larva (brief). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 612.
1856. Larva. Letzner. Arb. Schles. Ges. 104–106.
1857. Larva, pupa (figs.). Curtis. Journ. Roy. Agri. Soc. Eng. 58. pl.
1874. Larva, pupa. Kaltenbach. Pflanze feinde. 511.

LINA TREMULÆ Fabr.

1837. Larva, pupa (figs.). Ratzeburg. Forst. Insect. i. 245. pl. xx.
1843. Egg, larva, pupa (brief). Klingelhofer. Ent. Zeit. Stett. 85.
1880. Larva. Anony. Am. Ent. iii. 161.
1889. Larva, pupa (figs.). Lugger (after Taschenberg). Bull. No. 9. Exp. St. Minn. 55.

LINA LAPPONICA Linn.

1857. Larva. Mærkel. Allg. Nat. Zeit. 174.
1875. Larva (habits). Letzner. Arb. Schles. Ges. Breslau. 170.
1882. Larva (brief). Harrington. Rep. Ent. Soc. Ont. 59.
1889. Larva (brief). Lugger. Bull. No. 9. Exp. St. Minn. 55.

LINA SCRIPTA Fabr.

1855. Larva (brief). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 611.
1880. Larva, pupa (figs.). Riley. Am. Ent. iii. 157–161.
1881. Larva, pupa (figs.). Packard. Ins. Inj. For. & Sh. Tr. 116 (after Riley).

1884. Larva (brief). Riley. Rep. U. S. Dept. Agri. 336–340.
1889. Larva (fig.). Lugger. Bull. No. 9. Exp. St. Minn. 53, 54.

PHYLLODECTA VULGATISSIMA Linn.

1775. Larva, pupa (figs.). De Geer. Mem. v. 401. pl. ix. figs. 27–33.
1857. Larva, pupa. Cornelius. Stett Ent. Zeit. xviii. 392–399.

MONOCESTA CORYLI Say.

1878. Egg, larva, pupa (figs.). Riley. Rep. U. S. Dept. Agri. 246.
1881. Larva, pupa (figs.). Packard. Ins. Inj. For. & Sh. Tr. 64.

ANGELASTICA HALENSIS Linn.

1874. Biological note. Kaltenbach. Pflanze feinde. 308.

DIABROTICA VITTATA Fabr.

1869. Larva, pupa (figs.). Packard. Guide. 505.
1870. Larva, pupa (figs.). Riley. 2nd Rep. Nox. Ins. Mo. 65
1871. Larva, pupa (brief). Glover. Rep. U. S. Dept. Agri. 74 (1870).
1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 170.
1875. Larva (fig.). Cook. 12th Rep. St. Bd. Agri. Mich. 122 (1873).
1876. Larva (fig. only). Thomas. 1st Rep. Nox. Ins. Ill. 165.
1878. Larva, pupa (figs.). Saunders. Rep. Ent. Soc. Ont. 30.
1882. Larva (brief). Harrington. Rep. Ent. Soc. Ont. 59.
1883. Larva, pupa (figs.). Saunders. Ins. Inj. Fruit. 363.
1884. Larva (fig.). Edge. Agricul. Penn. 65.

DIABROTICA LONGICORNIS Say.

1884. Larva, pupa (figs.). Forbes. 2nd Rep. Nox. Ins. Ill. 55 (1883).

TRIRHABDA TOMENTOSA Linn.

1888. Larva (brief). Lintner. 4th Rep. Inj. Ins. N. Y. 142 (as *T. canadensis*).
1890. Larva. Beutenmüller. Can. Ent. xxii. 36.

GALERUCA XANTHOMELÆNA Schr.

1841. Egg, larva (brief). Harris. Inj. Ins. Mass. 73 (as *G. calmariensis*).
1867. Egg, larva, pupa. Glover. Rep. U. S. Dept. Agri. 62. (as *G. calmariensis*).
1867. Larva, pupa. Cornelius. Stett. Ent. Zeit. xxviii. 213, 214.
1871. Egg, larva. Glover. Rep. U. S. Dept. Agri. 73.
1882. Egg, larva, pupa (figs.). Riley. Rep. U. S. Dept. Agri. 159–170.
1882. Egg, larva, pupa (figs.). Anony. (quotes Riley). Scient. Am. xvii. 6885.
1883. Egg, larva, pupa (figs.). Riley. Rep. U. S. Dept. Agri. 160. pl. xii.
1885. Egg, larva, pupa (figs.). Riley. Bull. U. S. Dept. Agri. 6, 7.
1886. Egg, larva, pupa (figs.). Buckhout. Rep. Penn. Bd. Agri. 214. pl. iii.
1888. Egg, larva, pupa (figs.). Lintner. 4th Rep. Nox. Ins. N. Y. 143.
1888. Egg, larva, pupa (figs.). Riley. Bull. No. 10. Div. Ent. 9.
1889. Egg, larva, pupa (figs.). Lintner. 5th Rep. Nox. Ins. N. Y. 235.

GALERUCA MARGINELLA Kby.

1869. Larva, pupa (figs.). Packard. Guide. 505.

GALERUCA SAGITTARIÆ Gyll.

1883. Egg, larva, pupa. Schaupp. Bull. Bk. Ent. Soc. vi. 54.

BLEPHARIDA RHOIS Forst.

1874. Egg, larva, pupa (figs). Riley. 6th Rep. Nox. Ins. Mo. 118-122.
1876. Larva. Thomas. 1st Rep. Nox. Ins. Ill. 167.
1889. Egg, larva, pupa (figs.). Fernald (after Riley). Ann. Rep. Exp. St. Mass. 10.

DISONYCHA COLLARIS Fabr.

Larva, pupa. Murtfeldt. Bull. No. 22. U. S. Div. Ent. 76.

HALTICA CHALYBEA Ill.

1854. Larva (brief). Harris. Rep. Ins. & Diseases Inj. Veget. 11 (Am. Pom. Soc,).
1866. Larva. Walsh. Pract. Ent. i. 40 (as *Graptodera chalybea*).
1867. Larva (brief). Walsh. Pract. Ent. ii. 50.
1869. Larva (brief). Packard. Guide. 507 (as *Graptodera chalybea*).
1876. Larva, pupa (figs.). Riley. 3rd Rep. Nox. Ins. Mo. 79–81.
1874. Larva (fig. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 173.
1876. Larva (fig.). Thomas (quotes Riley). 1st Rep. Nox. Ins. Ill. 170.
1877. Egg, larva (fig.). Gott. Rep. Ent. Soc. Ont. 45.
1878. Egg, larva, pupa (figs.). Perkins. 5th Rep. Vermont Bd. Agri. 282.
1880. Larva, pupa (figs.). Anony. Am. Ent. iii. 183.
1882. Larva, pupa (figs.). Harrington. Rep. Ent. Soc. Ont. 60.
1883 Larva, pupa (figs.). Saunders. Ins. Inj. Fruit. 278.
1888. Larva (fig. only). Lintner. 4th Rep. Nox. Ins. N. Y. 96.

HALTICA BIMARGINATA. Say.

1888. Larva, pupa. Lintner. 4th Rep. Inj. Ins. N. Y. 98.

HALTICA FOLIACEA Lec.

1887. Larva. Riley. Scient. Am. June 16 (as *G. punctipennis*).
1887. Larva. Riley. Gardner's Monthly. xxix. 216.
1888. Egg, young and mature larva. Murtfeldt. Insect Life. i. 74–76.

PHYLLOTRETA VITTATA Fabr.

1869. Larva, pupa (figs.). Shimer. Am. Nat. ii. 150 (as *H. striolata*).
1869. Larva, pupa figs.). Packard (quotes Shimer). Guide. 507.
1869. Larva, pupa (figs.). Shimer. Am. Ent. i. 158 (as *H. striolata*).

1876. Larva. Thomas. 1st Rep. Nox. Ins. Ill. 169.
1882. Larva, pupa (figs.). Harrington. Rep. Ent. Soc. Ont. 60.
1883. Larva, pupa (figs.). Edge. Agri. Penn. 69.
1883. Larva, pupa (figs.). Saunders. Ins. Inj. Fruit. 330.
1884. Egg, larva, pupa. Riley. Rep. U. S. Dept. Agri. 301-304.

PHYLLOTRETA ZIMMERMANII Cr.

1884. Larva, pupa (figs.). Riley. Rep. U. S. Dept. Agri. 304–308. pl. iv.

DIBOLIA ÆREA Mels.

1879. Larva. Comstock. Rep. U. S. Dept. Agri. 248.

MICRORHOPALA VITTATA Fabr.

1837. Larva (figs.). Harris. Journ. Bost. Nat. Hist. Soc. i. 147.

ODONTOTA RUBRA Web.

1837. Larva, pupa (fig.). Harris. Journ. Bost. Nat. Hist. Soc. i. 143 (as *H. rosea*).
1869. Larva, pupa. Packard (quotes Harris). Guide. 503.
1883. Larva. Saunders. Ins. Inj. Fruit. 121.

ODONTOTA DORSALIS Thunb.

1837. Pupa (fig.). Harris. Journ. Bost. Nat. Hist. i. 146.
1839. Pupa (fig.). Westwood. Intro. Ins. i. 379 (as *H. suturalis*).
1868. Larva (brief). Walsh & Riley. Am. Ent. i. 58 (as *H. suturalis*).
1880. Larva (brief). Chambers. Am. Ent. iii. 60 (as *H. suturalis*).
1881. Larva (brief). Packard. Ins. Inj. For. & Sh. Tr. 100 (as *H. suturalis*).

PHYSONOTA UNIPUNCTATA Say.

1869. Larva. Walsh & Riley. Am. Ent. ii. 4 (as *P. 5-punctata*).
1870. Larva (fig.) Riley. 2nd Rep. Nox. Ins. Mo. 59.
1885. Larva (brief). Canfield. Can. Ent. xvi. 227.
1885. Larva (brief). Hamilton. Can. Ent. xvi. 134.

CASSIDA BIVITTATA Say.

1865. Larva. Thomas. Trans. Ill. Agri. Soc. v. 433.
1868. Larva. Riley. Prairie Farmer. Annual. 53.
1869. Larva, pupa (figs.) Walsh & Riley. Am. Ent. i. 235.
1870. Larva (fig.). Riley. 2nd Rep. Nox. Ins. Ill. 61.
1874. Larva, pupa (figs. only) Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 175.
1876. Larva, pupa (figs. only). Thomas. 1st Rep. Nox. Ins. Ill. 172.

CASSIDA NIGRIPES Oliv.

1869. Larva, pupa (figs.). Walsh & Riley. Am. Ent. i. 238.
1870. Larva, pupa (figs.). Riley. 2nd Rep. Nox. Ins. Mo 63.

COPTOCYCLA AURICHALCEA Fabr.

1841. Larva (brief). Harris. Inj. Ins. Mass. 98.
1865. Larva (brief). Thomas. Trans. Ill. Agri. Soc. v. 433.

1869. Egg, larva, pupa (figs.). Walsh & Riley. Am. Ent. i. 237.
1869. Larva (brief). Packard. Guide. 504.
1870. Larva, pupa (figs.). Riley. 2nd Rep. Nox. Ins. Mo. 62.
1882. Larva (brief). Harrington. Rep. Ent. Soc. Ont. 62.
1890. Larva (brief). Lintner. 6th Rep. Inj. Ins. N. Y. 125, 126.

Coptocycla guttata Oliv.

1869. Egg, larva, pupa (figs.). Walsh & Riley. Am. Ent. i. 237.
1870. Larva, pupa (figs.). Riley. 2nd Rep. Nox. Ins. Mo. 63.

Chelymorpha Argus Licht.

1869. Larva (fig.). Walsh & Riley. Am. Ent. ii. 4 (as *Ch. cribraria*).
1869. Larva (brief), pupa (fig.). Packard. Guide. 504.
1870. Pupa (fig.). Riley. 2nd Rep. Nox. Ins. Mo. 58.
1877. Pupa (fig. only). Packard. Half Hours Ins.
1882. Larva, pupa (brief). Harrington. Rep. Ent. Soc. Ont. 61.
1883. Pupa (fig.). Saunders. Ins. Inj. Fruit. 315.

BRUCHIDÆ.

Caryoborus arthriticus Fabr.

1869. Larva (habits). Glover. Rep. U. S. Dept. Agri. 71 (1868).
1881. Larva (habits). Dury. Can. Ent. xiii. 21.

Bruchus pisi Linn.

1761. Larva (notes). Kalm. Voy. to America. ii. 294.
1775. Larva (notes). De Geer (quotes Kalm). Mem. v. 380.
1815. Larva (notes). Kirby & Spence (quote Kalm). Intro. Ent. i. p.
1839. Larva (notes). Westwood (quotes Kalm). Intro. Ins. i. 330.
1841. Larva (habits). Harris. Inj. Ins. Mass. 56.
1854. Larva (biological notes). Kollar. Vert. z. b. Ges. Wien. iv. 27–30.
1854. Larva, pupa (des). Letzner. Arb. Schles. Ges. Breslau. 79–82.
1858. Larva (biological notes). Kollar. Vert. z. b. Ges. Wien. viii.421-425.
1862. Egg, larva, pupa (brief). Harris. Inj. Ins. Mass. 62.
1863. Larva (fig.). Ogerien. Hist. Nat. Journ. iii. 403.
1868. Larva (habits). Glover. Rep. U. S. Agri. Dept. 72.
1870. Larva (fig.). Glover. Rep. U. S. Dept. Agri. 92.
1871. Egg, larva, pupa (figs.). Riley. 3rd Rep. Nox. Ins. Mo. 44–50.
1874. Larva (habits). Stefanelli. Bull. Ent. Ital. vi. p.
1874. Egg, larva (brief). Thomas. 1st Rep. Nox. Ins. Ill. 28.
1878. Egg, larva, pupa (figs.). Perkins. 5th Rep. Vermont Bd. Agri. 269.
1879. Egg, larva (fig.). Saunders. Rep. Ent. Soc. Ont. 64.
1880. Larva (fig. only). Bethune. Rep. Ent. Soc. Ont. 50.
1883. Larva (fig.). Edge. Agri. Penn. 69.
1887. Egg, larva. Fernald. Rep. Bd. Agri. Mass. 90.

BRUCHUS OBSOLETUS Say.

1871. Larva (habits). Riley. 3rd Rep. Nox. Ins. Mo. 52.
1873. Larva (fig.). Packard. 3rd Rep. Inj. Ins. Mass. 15 (1872. as *Bruchus fabæ*).
1873. Larva (fig.). Packard. Am. Nat. vii. 537 (as *Bruchus fabæ*).

TENEBRIONIDÆ.

ELEODES DENTIPES Esch.

1878. Larva (fig.). Gissler. Bull. Bk. Ent. Soc. i. 19, 87.

ELEODES GIGANTEA Mann.

1878. Egg, larva (fig.). Gissler. Bull. Bk. Ent. Soc. i. 18, 87.

BLAPS MORTISAGA Linn.

1838. Larva. Patterson. Trans. Ent. Soc. Lond. ii. 99.
1839. Larva (fig. only). Westwood. Intro. Ins. i. 321.
1878. Larva (brief). Gissler. Bull. Bk. Ent. Soc. i. 87.
(This species is, perhaps, erroneously placed in our Catalogue.)

SCOTOBATES CALCARATUS Fabr.

1883. Larva (brief). Coquillett. Can. Ent. xv. 102.
1890. Larva, pupa. Beutenmüller. Psyche. vi.

XYLOPINUS SAPERDIOIDES Oliv.

1878. Larva (brief). Gissler. Bull. Bk. Ent. Soc. i. 87.

TENEBRIO MOLITOR Linn.

1720. Larva, pupa (figs.). Frisch. Beschreib. All. Ins. pt. 3. pl. i.
1775. Larva (fig.). De Geer. Mem. v. M. i. 35. pl. ii. figs. 6-11.
1795. Larva. Oliver. Entomol. iv. No. 57.
1796. Larva. Gœze. Belehr 35–67.
1802. Larva. Latreille. Hist. Nat. Crust. & Ins. x. 289.
1804. Larva (anatomy). Posselt. Beitr. Anatom. Ins. 25. pl. iii.
1807. Larva, pupa (figs.). Sturm. Deutschl. Ins. ii. 220–223.
1833. Larva, pupa (figs.). Hammerschmidt. Beitr. Ent. pl. vi.
1839. Larva. Westwood. Intro. Ins. i. 317.
1854. Larva. Mulsant. Nat. Hist. Col. Fr. Latig. 281.
1853. Larva Hagen. Stett. Ent. Zeit. xiv. 56.
1868. Larva, pupa (brief). Glover. Rep. U. S. Pat. Off. (Agri.) 100.
1869. Larva (brief). Packard. Guide. 474.
1872. Larva (fig.). Figuier. Ins. World. 499.
1878. Larva, pupa (figs.). Schiœdte. Naturh. Tidsskr. xi. pl. i.
1874. Larva (brief). Le Baron. 4th Rep. Nox. Ins. Ill. 121.
1883. Larva (fig. only). Calwer. Käferbuch. 585. pl. xlix. fig. 14.

TENEBRIO OBSCURUS Fabr.

1839. Larva (brief). Westwood. Intro. Ins. i. 318.

1854. Larva (Developments). Mulsant. Nat. Hist. Col. Fr. Latig. 186.
1874. Larva, pupa (fig.). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 123.
1878. Larva (brief). Gissler. Bull. Bk. Ent. Soc. i. 87.

Tribolium ferrugineum Fabr.

1839. Larva (fig.). Westwood. Intro. Ins. i. 319.
1854. Larva. Luccas. Ann. Soc. Ent. Fr. iii. 2. Bull. 51.
1855. Larva, pupa (figs.). Luccas. Ann. Soc. Ent. Fr. iii. 3. 249–259. pl. xiii. No. 3.
1878. Larva. Schiœdte. Nat. Tidsskr. xi. p.
1885. Larva (fig.). Lintner. 2nd Rep. Inj. Ins. N. Y. 137.

Gnathocerus cornutus Fabr.

1845. Larva, pupa (figs.). Motschulsky. Bull. Soc. Nat. Moscow. i. 80.
1854. Larva. Motschulsky. Etudes. Ent. iii. 67.
1870. Larva, pupa (figs.). Gernet. Horæ Soc. Ent. Ross. vi. 11. pl. ii.
1874. Larva, pupa (figs.). Letzner. Arb. Schles. Ges. Breslau. 166–168.
1878 Larva (brief). Gissler. Bull. Bk. Ent. Soc. i. 87.

Diaperis hydni Fabr.

1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Nox Ins. Ill. 125.
1880. Larva (brief). Harrington. Can. Ent. xii. 261.

Platydema excavatum Say.

1878. Larva (brief). Gissler. Bull. Bk. Ent. Soc. i. 87.

Boletotherus bifurcus Fabr.

1869. Larva, pupa (figs.). Packard. Guide. 474.
1878. Larva (brief). Gissler. Bull. Bk. Ent. Soc. i. 87.
1882. Larva, pupa. Hayward. Journ. Bost. Zoo. Soc. i. 35, 36.

ÆGIALITIDÆ.

Ægialites debilis Mann.

1888. Larva (fig.). Horn. Trans. Am. Ent. Soc. xv. pl. iii.

CISTELIDÆ.

Androchirus fuscipes Mels.

1883. Larva. Coquillett. Can. Ent. xv. 101.

OTHNIIDÆ.

Othnius lugubris Horn.

1888. Larva (fig.). Horn. Trans. Am. Ent. Soc. xv. pl. iii.

MELANDRYIDÆ.

Xylita lævigata Hellw.

1842. Larva. Erichson. Wiegm. Archiv. viii. pl. 1. 368.

1855. Larva, pupa (figs.). Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 248.

ŒDEMERIDÆ.

NACERDES MELANURA Linn.

1861. Larva, pupa (figs.). Herklotz. Tidsskr. Ent. iv. 164-166. pl. xi.
1863. Larva, pupa (figs.). Perris. Hist. Pin. Mar. i. 452
1877. Larva. Perris. Larves des Col. 350.
1880. Egg, larva. Moody. Psyche. iii. 68.
1880. Larva (figs.). Schiœdte. Naturh. Tidsskr. xii. pl. xvii.

MORDELLIDÆ.

MORDELLA 8-PUNCTATA Fabr.

1874. Larva, pupa (figs.). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 114.

MORDELLA ? Sp.

1881. Larva (note). Chambers. Can. Ent. xiii. 173.

ANTHICIDÆ.

ANTHICUS FLORALIS Linn.

1883. Larva. Rey. Ann. Soc. Linn. Lyon. new ser. xxix. 141, 142.

PYROCHROIDÆ.

PYROCHROA FLABELLATA Fabr.

1880. Larva. Moody. Psyche. iii. 76.

SCHIZOTUS CERVICALIS Newm.

1880. Larva (brief). Moody. Psyche. iii. 76.

DENDROIDES CANADENSIS Lat.

1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 117.
1880. Larva. Moody. Psyche. iii. 76.

DENDROIDES CONCOLOR Newm.

1880. Larva. Moody. Psyche. iii. 76.

MELOIDÆ.

MELOE sp. (probably *M. angusticollis*).

1862. Larva. Packard. 2nd Rep. Nat. Hist. & Geo. Surv. Maine. 190.
1869. Larva (fig.). Packard. Guide. 478.
1869. Larva (fig.). Packard. Am. Nat. ii. 199. pl. iv.
1874. Larva (fig. only). Le Baron (after Packard). 4th Rep. Nox. Ins. Ill. 114.
1876. Larva (fig.). Saunders. Rep. Ent. Soc. Ont. 27.
1878. Larva (fig.). Riley. Am. Nat. xii. 216.
1878. Larva (fig.). Riley. 1st Rep. U. S. Ent. Com. 259.

1880. Larva, pupa. Packard. Zoology. 373 (2nd Ed.).
1883. Larva, pupa (figs.). Packard. Am. Nat. xvii. 941

Horia maculata Swed.

1825. Larva (fig.). Guilding. Trans. Linn. Soc. Lond. xiv. 316. pl. viii.

Epicauta cinerea Forst.

1841. Larva (brief). Harris. Inj. Ins. Mass. 112.
1878. Pupa (fig.). Riley. Am. Nat. xii. pl. i. fig. 9.

Epicauta vittata Fabr.

1876. Egg, larva. Saunders (quotes Riley). Rep. Ent. Soc. Ont. 29.
1878. Egg, larva, pupa (figs.). Riley. Am. Nat. xii. 285. pl. i.
1878. Egg, larva, pupa (figs.). Riley. 1st Rep. U. S. Ent. Com. 298–300 pl. iv.
1890. Larval habits. Lintner. 6th Rep. Inj. Ins. N. Y. 132–134.

Hornia minutipennis Riley.

1878. Larva (fig.). Riley. Am. Nat. xii. 218. pl. i. figs. 3*a*, 13*c*.
1878. Egg, larva (fig.). Riley. 1st Rep. U. S. Ent. Com. 296. pl. iv.

STYLOPIDÆ.

Stylops Childreni Gray.

1869. Larva (fig.). Packard. Guide. 482.
1869. Larva (fig.). Packard. Am. Nat. ii. 201. pl. v. fig. 6.

ATTELABIDÆ.

Attelabus bipustulatus Fabr.

1881. Larva, pupa. Packard (quotes Murtfeldt). Ins. Inj. For. & Sh. Tr. 51.

OTIORHYNCHIDÆ.

Otioryhnchus sulcatus Fabr.

1834. Larva (fig.). Bouche. Nat. Ins. 201. pl. x. figs. 15–20.
1837. Larva, pupa (figs). Westwood. Gard. Mag. xiii. 157.
1839. Larva, pupa (figs.). Westwood. Intro. Ins. i. 344.
1849. Larva (brief). Preston. Gardner's Chron. 744.
1869. Larva (brief). Lucas. Ann. Soc. Ent. Fr. iv. 9. 50.
1876. Larva. Snellen. Tijdsskr. Ent. xix. 210.
1879. Larva, pupa (figs.). Ormerod. Inj. Ins. 6.
1884. Larva (brief). Forbes. 2d Rep. Nox. Ins. Ill. 177.

Otiorhynchus ovatus Linn.

1853. Larva (notes). Laboulbene. Ann. Soc. Ent. Fr. iii. 1. Bull. 48.

Aramigus Fulleri Horn.

1878. Egg, larva, pupa (figs.). Riley. Rep. U. S. Dept. Agri. 256, 257. pl. vii.
1885. Egg, larva, pupa (figs.). Lintner. 2d Ann. Rep. Inj. Ins. 143.

CURCULIONIDÆ.

1890. Food-Habits. Beutenmüller. Can. Ent. xxii. p.

SITONES HISPIDULUS Germ.

1876. Larva, pupa. Brischke. Ent. Monatblatt. 42.

ITHYCERUS NOVEBORACENSIS Forst.

1868. Larva (fig.). Walsh & Riley. Am. Ent. i. 221.
1869. Larva, pupa (figs.). Walsh & Riley. Am. Ent. ii. 26.
1871. Larva. Riley. 3d Rep. Nox. Ins. Mo. 57.
1874. Larva (fig. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 136.
1876. Larva (fig.). Thomas. 1st Rep. Nox. Ins. Ill.
1883. Larva (fig.). Saunders. Ins. Inj. Fruit. 196.

PODAPION GALLICOLA Riley.

1883. Larva (brief). Riley. Bull. Bk. Ent. Soc. iv. 62.
1887. Larva (brief). Fletcher. Rep. Ent. Exp. Farms. 39.

LISTRONOTUS LATIUSCULUS Boh.

1890. Larva, pupa (figs.). Weed. Bull. Ohio Exp. St. i. 10, 11. pl. ii. fig. 1.

PHYTONOMUS PUNCTATUS Fabr.

1881. Egg, larva. Riley. Am. Nat. xv. 12.
1882. Egg, larva, pupa (figs.). Riley. Rep. U. S. Dept. Agri. 171–179. pl. x.
1882. Egg, larva, pupa (figs.). Lintner. 1st Rep. Inj. Ins. N. Y. 250.
1884. Egg, larva, pupa (figs.). Cutting. 8th Rep. Vermont Bd. Agri. 271, 272.
1884. Larva, pupa (figs.). Buckhaut. Agricul. Penn. 216.
1887. Egg, larva, pupa (figs.). Cook (quotes Riley). Beal's Grasses N. Am. i. 380–383.

PISSODES STROBI Peck.

1817. Larva. Peck. Mass. Agricul. Reposit. iv. 205–211. pl. i.
1825. Larva. Peck. Zoo. Journ. ii. 490–492.
1841. Larva (brief). Harris. Inj. Ins. Mass. 64.
1858. Larva. Fitch. 4th Rep. Nox. Ins. (Trans. N. Y. Agri. Soc.) 732-736 (1857).
1869. Larva (brief). Glover. Rep. U. S. Dept. Agri. 71 (1868).
1869. Larva, pupa (figs). Riley. Am. Ent. ii. 164.
1869. Larva, pupa (figs). Packard. Guide. 486.
1874. Larva, pupa (figs.). Le Baron (after Packard). 4th Rep. Nox. Ins. Ill. 139.
1876. Larva, pupa (figs.). Thomas. 1st Rep. Nox. Ins. Ill. 133.
1877. Larva, pupa (figs. only). Packard. Half Hours Ins. 299.
1877. Larva, pupa (figs.). Cook. 16th Rep. Mich. Bd. Agricul. 251.
1880. Larva, pupa (figs.). Fuller. Am. Ent. iii. 5.
1880. Larva, pupa (figs. only). Packard. Zoology. 372. 2nd Ed.
1881. Larva, pupa (figs.). Packard. Ins. Inj. For. & Sh. Tr. 187.

1882. Larva, pupa (figs.). Packard. 3rd Rep. U. S. Ent. Com. pl. xiii.
1883. Larva (brief). Saunders. Rep. Ent. Soc. Ont. 55.
1885. Larva, pupa (figs.). Packard. Rep. U. S. Dept. Agri. 322-325.
1886. Larva, pupa (figs.). Buckhaut. Agricul. Penn. 214. pl. iii.
1888. Larva, pupa (figs.). Lintner. 4th Rep. Inj. Ins. N. Y. 24.
1889. Larva, pupa (figs.). Smith. Garden & Forest. ii. p.

HYLOBIUS PALES Hbst.

1841. Larva (brief). Harris. Inj. Ins. Mass. 62.
1883. Larva (brief). Saunders. Rep. Ent. Soc. Ont. 55.

LIXUS CONCAVUS Say.

1889. Egg, larva, pupa. Webster. Ent. Am. v. 13-16.
1890. Egg, larva, pupa (figs.). Weed. Bull. Ohio Ex. St. iii. No. 8. 2nd Ser. 232.
1890. Larva, pupa (figs.). Weed. Journ. Col. Hort. Soc. v. 73.

LIXUS MACER Lec.

1883. Egg, larva (brief). Coquillett. Can. Ent. xv. 113.
1889. Egg, larva, pupa (Biolog. notes). Webster. Ent. Am. v. 11.

LIXUS PARCUS Lec.

1881. Biological Notes. Riley. Proc. Ent. Soc. Wash. i. 33.

LISSORHOPTRUS SIMPLEX Say.

1882. Larva (fig.). Riley. Rep. U. S. Dept. Agri. 132. pl. vi. fig. 4.

MAGDALIS OLYRA Hbst.

1869. Larva, pupa (figs.). Packard. Guide. 488.
1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th. Rep. Nox. Ins. Ill. 139.
1876. Larva, pupa (fig. only). Thomas. 1st Rep. Nox. Ins. Ill. 132.
1877. Larva, pupa (figs. only). Packard. Half Hours Ins. 241.
1881. Larva, pupa (figs.). Packard. Ins. Inj. For. & Sh. Tr. 28.
1884. Larva (brief). Bowditch. Journ. Bost. Zoo. Soc. iii. 6.

MAGDALIS ARMICOLLIS Say.

1875. Larva, pupa (brief). Hubbard. Psyche. i. 6 (1875).

ANTHONOMUS 4-GIBBUS Say.

1871. Egg, larva, pupa (figs.). Riley. 3rd Rep. Nox. Ins. Mo. 29-35.
1874. Larva, pupa (figs.). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 141.
1876. Egg, larva. Thomas. 1st Rep. Nox. Ins. Ill. 135.
1883. Larva, pupa (figs.). Saunders. Ins. Inj. Fruit. 134.

ANTHONOMUS SUTURALIS Lec.

1869. Larva. Packard. Guide. 488.
1883. Larva (fig.). Saunders. Ins. Inj. Fruit. 375.

COCCOTORUS SCUTELLARIS Lec.

1871. Larva (brief). Riley. 3rd Rep. Nox. Ins. Mo. 39.
1876. Larva (brief). Thomas. 1st Rep. Nox. Ins. Ill. 136 (as *Anthonomus prunicida*).
1883. Larva (brief). Saunders. Ins. Inj. Fruit. 188.
1888. Egg, larva (brief). Bruner. Insect Life. i. p.

CIONUS SCROPHULARIÆ Linn.

1775. Larva (fig.). De Geer. Mem. v. p.
1779. Larva (fig.). Schaeffer. Abhandl. Ins. iii. pl. ix.
1790. Larva (habits). Rossi. Fauna Etrusca. 121.
1795. Larva (brief). Herbst. Nat. Syot. vi. 184.
1803. Larva, pupa (brief). Latreille. Nat. Hist. Crust. & Ins. xi. 72.
1843. Larva. Huber. Mem. Soc. Sc. Phys. & Nat. Hist. Geneve. x. 15–34.
1849. Larva. Westwood. Gardner's Chronicle. 228.
1850. Larva. Perris. Ann. Soc. Linn. Lyon. ii. 291.
1853. Larva. Letzner. Arb. Schles. Ges. Breslau. 177.
1879. Larva. Osborne. Ent. Month. Mag. xvi. 18.

GYMNETRON TETER Fabr.

1859. Larva, pupa (figs.). Heeger. Sitzb. Ak. Wiss. Wien. 218–221. pl. iii.
1874. Larva, pupa. Kaltenbach (quotes Heeger). Pflanzen feinde. 465.

CONOTRACHELUS NENUPHAR Hbst.

1841. Larva (brief). Harris. Inj. Ins. Mass. 66.
1854. Larva (fig.). Glover. Rep. U. S. Pat. Off. (Agri.) 81. pl. vii.
1861. Larva (fig.). Rathvon. Rep. U. S. Pat. Off. (Agri.) 605.
1862. Larva (brief). Harris. Inj. Ins. 76.
1865. Larva, pupa (figs.). Trimble. Ins. Enemies Fruit. 33. pl. vi.
1869. Larva. pupa (figs.). Packard. Guide. 489.
1870. Larva, pupa (figs.). Saunders. Can. Ent. ii. 137.
1870. Larva, pupa (figs.). Riley. Am. Ent. ii. 130.
1871. Larva, pupa (figs.). Saunders. Can. Ent. iii. 26.
1871. Eggs, larva, pupa (figs.). Riley. 3rd Rep. Nox. Ins. Mo. 11.
1873. Larva, pupa (figs.). Cook. 12th Rep. Mich. Bd. Agri. 132.
1874. Larva, pupa (figs.). Le Baron. 4th Rep. Nox. Ins. Ill. 142.
1876. Egg, larva, pupa (figs.). Thomas. 1st Rep. Nox. Ins. Ill. 138.
1877. Larva, pupa (figs.). Gott. Rep. Ent. Soc. Ont. 46.
1877. Larva, pupa (figs.). Packard. Half Hours Ins. 273.
1879. Larva, pupa (figs.). Gott. Rep. Ent. Soc. Ont. 84.
1880. Larva, pupa (figs.). Harrington. Rep. Ent. Soc. Ont. 53.
1881. Larva, pupa (figs.). Chase. Trans. Wis. Agri. Soc. xix. 452.
1883. Egg, larva, pupa (figs.). Saunders. Ins. Inj. Fruit. 181.
1885. Larva, pupa (figs.). Fletcher. Rep. Ent. Exp. Farms. 25.

CONOTRACHELUS CRATÆGI Walsh.

1871. Larva, pupa (figs.). Riley. 3d Rep. Nox. Ins. Mo. 35-39.
1876 Larva (brief). Thomas. 1st Rep. Nox. Ins. Ill. 141.
1883. Larva (brief). Saunders. Ins. Inj. Fruit. 226.

RHYSSEMATUS LINEATICOLLIS Say.

1889. Larva (brief). Webster. Insect Life. ii. 112.

TYLODERMA FOVEOLATUM Say.

1889. Egg, larva (brief). Webster. Insect Life. ii 111.

TYLODERMA FRAGARIÆ Riley.

1871. Larva (fig.). Riley. 3rd Rep. Nox. Ins. Mo. 42.
1872. Larva (fig. only). Anony. (after Riley). Am. Nat. vi. 293.
1874. Larva (fig. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill 143.
1880. Larva (fig.). Harrington. Rep. Ent. Soc. Ont. 54.
1880. Larva (fig. only). Fuller. Am. Ent. iii. 110.
1883. Larva, pupa (figs.). Forbes. Trans. Wis. Hort. Soc. xiii.
1883. Larva, pupa (figs.). Forbes. 1st Rep. Nox. Ins. Ill. 64.
1883. Larva (fig.). Saunders. Ins. Inj. Fruit. 323.
1884. Larva (fig.). Forbes. 2nd Rep. Nox. Ins. Ill. 142. pl. ix.
1889. Egg. Webster. Ins. Life. ii. 110.

CRYPTORHYNCHUS PAROCHUS Hbst.

1881. Larva, pupa (brief). Schaupp. Bull. Bk. Ent. Soc. iv. 35.

CRYPTORHYNCHUS LAPATHI Linn.

1791. Larva, pupa (figs.). Curtis. Trans. Linn. Soc. Lond. i. 86–89. pl. v.
1793. Larva, pupa (figs.). Reiche (quotes Curtis). Mag. Thier. i. 11–14. pl. i.
1854. Larva, pupa (figs.). Loudon. Arbor. Britan. 1479 (2d Ed.).
1863. Larva, pupa (biolog. notes). Westwood. Trans. Ent. Soc. Lond. Pro. 65.
1864. Larva, pupa (figs.). Westwood. Gardner's Chron. Jan. 16th.
1867. Larva (biolog. notes). Goureau. Ann. Soc. Ent. Fr. iv. 7. Bull. 85.
1868. Larva, pupa (figs.). Ratzeburg. Die Waldverderbuiss. ii. 247. pl. xlix.
1873. Larva. Erne. Mitth. Schweiz. Ent. Ges. iv. 138.

CRAPONIUS INÆQUALIS Say.

1869. Larva, pupa (brief). Glover. Rep. U. S. Agri. 76 (1868).
1869. Larva (fig.). Packard. Guide. 490.

CEUTORHYNCHUS CYANIPENNIS Grm.

1845. Biolog. Notes. Guerin Meneville. Ann. Soc. Ent. Fr. ii. 3. Bull. 33.
1855. Biolog. Notes. Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 562.
1855. Larva. Haimhoffer. Verh. z. b. Ges. Wien. v. 525–529.
1865. Larva (fig.). Taschenberg. Schädl. Insect. 57–59. pl. ii. fig. 11.
1866. Larva, pupa (figs.). Kessler. Lebengeshichte. 3–25.

1874. Larva. Kaltenbach. Pflanzen feinde. 31.
1874. Larva. Nowicki. Verh. z. b. Ges. Wien. xxiv. 364.

BARIDIUS TRINOTATUS.

1841. Larva (brief). Harris. Inj. Ins. Mass.
1862. Larva (brief). Harris. Inj. Ins. Mass. 81.
1868. Larva, pupa (figs.). Walsh & Riley. Am. Ent. i. 22.
1869. Larva, pupa (figs.). Packard. Guide. 491.
1870. Larva (brief). Compton. Prize Ess. Cult. Potato. 20.
1876. Larva (brief). Thomas. 1st Rep. Nox. Ins. Ill. 142.
1880. Larva, pupa (figs.). Harrington. Rep. Ent. Soc. Ont. 56.

BALANINUS NASICUS Say.

1861. Larva (fig.). Rathvon. Rep. U. S. Pat. Off. 605 (as *B. Sayi*).

BALANINUS CARYATRYPES Boh.

1872. Larva (fig.). Packard. 2d Ann. Rep. Inj. Ins. Mass. 17.
1877. Larva (fig.). Packard. Half Hours Ins. 247 (as Chestnut weevil).
1881. Larva (fig.). Packard. Ins. Inj. For. & Sh. Tr. 93.

BRENTHIDÆ.

CYLAS FORMICARIUS Fabr.

1879. Egg, larva, pupa. Comstock. Rep. U. S. Dept. Agri. 250.

EUPSALIS MINUTA Dr.

1841. Larva, pupa (brief). Harris. Inj. Ins. Mass. 60 (as *B. septrionalis*).
1855. Larva (brief). Chapuis et Candeze (quotes Harris). Mem. Soc. Sc. Liege. viii. 546.
1862. Larva, pupa. Harris. Inj. Ins. Mass. 63–69 (as *B. septrionalis*).
1874. Larva, pupa (figs.). Riley. 6th Rep. Nox. Ins. Mo. 113–118.
1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 130.
1881. Larva, pupa (figs.). Packard (quotes Riley). Ins. Inj. For. & Sh. Tr. 22.
1887. Larva, pupa (figs.). Harrington. Rep. Ent. Soc. Ont. 32.

CALANDRIDÆ.

RHYNCHOPHORUS CRUENTATUS Fabr.

1873. Larva, pupa, cocoon. Summers. Can. Ent. v. 123 (as *R. Zimmermanii*).
1878. Larva (brief). Horn. Trans. Am. Ent. Soc. vii. 39.

RHYNCHOPHORUS PALMARUM Linn.

1705. Larva (fig.). Marian. Insects Surinam. 48. pl. xlviii.
1796. Larva (fig.). Stedman. Exped. South Am. ii. 22. pl. (as Palmetto weevil).
1803. Larva (brief). Latreille. Hist. Nat. Crust. & Ins. xi. 54.
1806. Larva, pupa (fig.). Shaw. Gen. Zoology Ins. pt. i. 62. pl. xx (as *Curculio palmarum*).

1832. Larva, pupa, cocoon (figs. only). J. D. Mag. Nat. Hist. v. 466 (as *Calandra palmarum*).

1845. Larva, pupa (figs.). Blanchard. Hist. des Insects. pl. x.

SPHENOPHORUS PARVULUS Gyll.

1886. Larva. Forbes. Misc. Essays. 22 (Trans. Agri. Soc. Ill. 1885).
Larva (brief). Brunner. Bull. No. 22. U. S. Div. Ent. 99.

1890. Larva. Forbes. 16th Rep. Nox. & Ben. Ins. Ill. 67 (1887–88).

SPHENOPHORUS ROBUSTUS Horn.

1882. Larva, pupa (figs.). Riley. Rep. U. S. Dept. Agri. 141-142. pl. viii.

SPHENOPHORUS OCHREUS Lec.

1889. Larva (fig.). Webster. Ins. Life. ii. 132-134.

1890. Larva (fig.). Webster. Bull. No. 22. Div. Ent. 53.

1890. Larva. Forbes. 16th Rep. Nox. & Ben. Ins. Ill. 66 (1887–88).

CALANDRA GRANARIA Linn.

1778. Larva. DeGeer. Mem. v. 360.

1795. Larva. Herbst. Natur. System. vi. 15.

1798. Larva (habits). Geoffroy. Hist. Abr. Ins. i. 285.

1803. Larva, pupa. Latreille. Hist. Nat. Crust. & Ins. xi. 54.

1834. Larva, pupa (figs.). Kerstenstein. Silberm. Rev. Ent. ii. 115-120.

1841. Larva (Biolog. notes). Harris. Inj. Ins. Mass. 70.

1842. Larva, pupa. Kollar. Verh. Landw. Ges. Wien. N. F. i. 139-145.

1846. Larva, pupa. Curtis. Journ. Roy. Agri. Soc. Eng. pt. 1. 97.

1854. Larva, pupa (figs.). Emmons. Ins. N. Y. 102. pl. ii.

1855. Larva, pupa (figs.). Nordlinger. Kl. Feinde. 153-163.

1869. Larva, pupa (figs.). Packard. Guide. 490.

1870. Larva. Westwood. Trans. Ent. Soc. Lond. Proc. 16.

1879. Larva. Fitch. The Entomologist. 41.

1879. Larva. Ormerod. The Entomologist. 51-54.

CALANDRA ORYZÆ Linn.

1841. Larva, (brief). Harris. Inj. Ins. Mass. 70.

1846. Pupa, (fig.). Curtis. Journ. Roy. Agri. Soc. pt. 1, 95.

1848. Larva, pupa. Kollar. Sitzb. Wien. Acad. v. 3.

1854. Larva, pupa (figs.). Glover. Rep. U. S. Pat. Off. 75.

1855. Biological Notes. Rogers. Stett. Ent. Zeit. xvi. 307.

1879. Larva. Fitch. The Entomologist. Feb.

PHLŒOPHAGUS SPADIX Hbst.

1888. Larva (brief). Jülich. Ent. Am. iv. 35.

SCOLYTIDÆ.

PITYOPHTHORUS CONSIMILIS Lec.

Habits. Schwarz. Proc. Ent. Soc. Wash. i. 164.

PITYOPHTHORUS CONCENTRALIS Eich.

Biological Notes. Schwarz. Proc. Ent. Soc. Wash. i. 163.

Pityophthorus annectens Lec.

Biological Notes. Schwarz. Proc. Ent. Soc. Wash. i. 164.
1877. Larvæ. Perris. Larves des Coleopt. 412.

Hypothenemus eruditus Westw.

1885. Egg, larva, pupa. Hubbard. Ins. Aff. Orange. 173.

Xyloterus bivittatus Kby.

1882. Larva, pupa (figs. only). Packard. 3d Rep. U. S. Ent. Com. pl. xiv figs. 1, 1 *a*.

Xyleborus cælatus Eich.

1882. Larva, pupa (figs. only). Packard. 3d Rep. U. S. Ent. Com. pl. xiv. figs. 2, 3.

Xyleborus xylographus Say.

1857. Egg, larva, pupa. Fitch. 4th. Rep. Nox. Ins. 720 (Trans. N. Y. Agri. Soc.).
1881. Egg, larva, pupa. Packard. Ins. Inj. For. & Sh. Tr. 165.

Xyleborus pyri Peck.

1819. Larva (biol. notes). Peck. Mass. Agri. Rep. v. 307–313.
1826. Larva (biol.). Peck. Zoo. Journ. 387–402.
1841. Larvæ (notes). Harris. Inj. Ins. Mass. 75.
1889. Biological notes. Schwarz. Proc. Ent. Soc. Wash. i. 138.

Dryocœtes affaber Mann.

1881. Larva, pupa (figs.). Packard. Ins. Inj. For. & Sh. Tr. 243.

Tomicus pini Say.

1858. Fig. of Galleries. Fitch. 4th Rep. Nox. Ins. 722 (Trans. N. Y. Agri. Soc. 1857).
1881. Pupa (fig.). Packard. Ins. Inj. For. & Sh. Tr. 169.

Tomicus calligraphus Germ.

1858. Burrows. Fitch. 4th Rep. Nox. Ins. 721 (Trans. N. Y. Agri. Soc. 1857).

Scolytus 4-spinosus Say.

1873. Larva, pupa (figs.). Riley. 5th Rep. Nox. Ins. Mo. 103-108.
1874. Larva, pupa (figs. only). Le Baron (after Riley). 4th Rep. Nox. Ins. Ill. 146.
1876. Larva, pupa (figs. only). Thomas (after Riley). 1st Rep. Nox. Ins. Ill. 145.
1881. Larva, pupa (figs.). Packard (after Riley). Ins. Inj. For. & Sh. Tr. 73.

Scolytus unispinosus Lec.

1886. Larva (borings). Smith. Ent. Am. ii. 125.

Scolytus rugulosus Ratz.

1837. Larva (biol. notes). Ratzeburg. Forst. Insect. i. 185.
1884. Larva (habits). Hagen. Can. Ent. xvi. 161.
1855. Larva (biol. notes). Nördlinger. Kleine Feinde. 187.
1867. Larva (biol. notes). Gourean. Ins. Nuis. aux Forets. 97.
1886. Larva (habits, etc.). Scudder. Can. Ent. xviii. 195.
1888. Larva (biolog. notes). Lintner. 4th Rep. Inj. Ins. N. York. 103–107.

Hylesinus trifolii Müll.

1807. Larva (biol. notes). Müller. Avis sur. une spece de Bostriche. 64.
1844. Larva. Schmitt. Ent. Zeit. Stett. v. 389–397.
1879. Larva, pupa (figs.). Riley. Rep. U. S. Dept. Agri. 248. pl. v. (1878).
1880. Egg, larva, pupa (figs.). Anony. Am. Ent. iii. 180.
1881. Larva, pupa (figs.). Lintner. Rep. N. Y. Agri. Soc. 16 (1880).
1881. Larva, pupa (figs.). Saunders. Rep. Ent. Soc. Ont. 43.
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1884. Larva, pupa (figs.). Buckhaut. Agricul. Penn. 215.
1887. Larva, pupa (figs.). Cook. Beal's Grasses N. Am. i. 375–378.

Dendroctonous terebrans Oliv.

1841. Larva (brief). Harris. Inj. Ins. Mass. 72.
1857. Larva (brief). Fitch. Rep. Nox. Ins. N. Y. 728 (Trans. N. Y. Agri. Soc. 1858).
1876. Larva (brief). Thomas. 1st Rep. Nox. Ins. Ill. 146.
1881. Larva (brief). Packard. Ins. Inj. For. & Sh. Tr. 175.

Crypturgus atomus Lec.

1882. Larva, pupa (figs. only). Packard. 3rd Rep. U. S. Ent. Com. pl. xiv. figs. 4, 5.

Hylurgops pinifex Fitch.

1882. Larva (fig.) Packard. 3rd Rep. U. S. Ent. Com. pl. xiii. fig. 4.

Phlœosinus dentatus Say.

1858. Borings. Fitch. 4th Rep. Nox. Ins. 750 (Trans. N. Y. Agri. Soc. 1857).

ANTHRIBIDÆ.

Cratoparis lunatus Fabr.

1855. Larva. Chapuis et Candeze. Mem. Soc. Sc. Liege. viii. 540.

PROCEEDINGS.

Meeting of October 3d, 1890.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Seven persons present.

OBJECTS EXHIBITED.

1. Bermuda Grass, *Cynodon dactylon*, inflorescence: by P. H. Dudley.

2. A sub-stage condenser: by J. D. Hyatt.

President Dudley furnished a description of his exhibit as follows:

"The specimen of Bermuda Grass exhibited is from the New Orleans and North Eastern Railroad embankment, in Mississippi, and was collected in June, 1890.

"'It is a low creeping perennial grass, with abundant short leaves at the base, sending up slender, nearly leafless culms, which have from three to five slender diverging spikes at the summit. The spikelets are sessile in two rows on one side of the slender spikes; they each have one flower with a short pediceled naked rudiment of a second flower; the outer glumes nearly equal, keeled, the flowering glume boat-shaped, broader and prominently keeled.' (Vasey.)

"This beautiful little grass in many parts of the South is of great value in protecting railroad embankments and levees from washing. Once planted it is extremely difficult to eradicate, soon re-grassing the roadbed, when ties have been renewed or other repairs made. In most cases the entire roadbed would be covered, the only portion of the track visible being the two bright surfaces of the line of rails. I did not notice the spikelets rising but one or two inches above the top of the rails, yet in some places so many were crushed on the rails by the drivers that the adhesion of the locomotive was affected.

"Though the Bermuda Grass is a native of tropical countries it rarely seeds in the Southern States, and is propagated by planting small pieces of its sod a few feet apart, the grass quickly growing and filling the entire space. It thrives in the hottest weather, and is little affected by drouth. The tops are killed by the frost, though the roots are hardy. The stability it

gives to a railroad embankment, or a levee is astonishing. In this respect it is unequalled by any other grass."

Mr. Hyatt stated that the condenser which he exhibited was constructed by himself on the principle announced some time since by Prof. Alfred M. Mayer ——— three plano-convex lenses, the largest one, of two inch focal distance, with a central stop, placed below, and two smaller lenses, paired, with their convex surfaces opposed to each other, and placed near the under surface of the stage. The combination gives an excellent dark ground illumination.

A discussion was held upon the atmospheric discoloration of the "Abbe glass." Specimens were exhibited, and were commented upon by Mr. Wales.

Meeting of October 17th, 1890.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Twenty persons present.

OBJECTS EXHIBITED.

1. Spider crab, *Libinia canaliculata*, zoea stage : by Ludwig Riederer.
2. Mantis shrimp, *Squilla empusa*, alima stage : by Ludwig Riederer.
3. Fore-tibia of the grasshopper, *Scudderia curvicauda* Serv., with auditory organ : by J. L. Zabriskie.
4. Moult of fore-tibia of *Orchelimum glaberrimum* Burm., with auditory organ : by J. L. Zabriskie.
5. Malachite from Paterson, N. J.: by James Walker.
6. Azurite from Paterson, N. J.: by James Walker.
7. Fungus in solution of cocaine : by Frank D. Skeel.
8. Sections of leaf of Long-leaved Pine of Colorado : by P. H. Dudley.

Dr. Dean remarked upon Mr. Riederer's exhibit of the alima stage of *Mantis* as an especially interesting slide.

A discussion upon the tenacity of life and the reproduction of lost parts among the crustaceæ was participated in by Messrs. Leggett, Dean, Lockwood and Helm.

Mr. Zabriskie said that the green grasshoppers in general are furnished with curious structures situated on either side of the

vertically flattened and enlarged proximal portions of the fore-tibiæ, which structures are said to be auditory organs. The tibia of *Scudderia* exhibited shows two elliptical structures, exactly opposed to each other, on the inner and outer surfaces of the leg, furnished with prominent rounded rims, and plainly seen by the unaided eye. When magnified, these elliptical enclosures are seen to be crossed by many fine transverse striæ. Exhibit No. 4 is from a specimen of *Orchelimum* which moulted in captivity. It is mounted so that a view is obtained from directly in front. A longitudinal slit can be observed in each elliptical enclosure, through which slits a view can be had into the interior of the moult, probably indicating that here, in the act of moulting, some delicate structures are torn away, which formerly maintained communication with the interior.

Dr. Skeel said his preparation was from an eight per cent. solution of cocaine, which three months ago was clear, but which now presented these forms of fungus.

Mr. Stephen Helm announced that he had been successful in finding at Greenwood Lake, amongst a good many other beautiful forms, the fresh water Zoophytes, *Lophopus crystallinus* and *Alcyonella fungosa*. The latter were in the ordinary orthodox cœnœcia. But in the lakes in Prospect Park, Brooklyn, by dredging, he had found *A. fungosa* in the most extraordinary abundance, and in colonies varying from the size of a bantam's egg to that of a man's head ; one in particular, of a pointed elliptical form, he found by actual measurement, was fourteen inches in the long, and eight inches in the short, or central diameter. On the estimate of 250 to the square inch, for the lophophores are quite close together, this particular colony must have contained the enormous number of nearly 100,000 individuals.

They were found encrusting the stems of water plants at Greenwood, and submerged twigs and branches of trees at Prospect Park, and were solid throughout the entire mass. The branch which held the large specimen also held six or eight others nearly as large. The whole would have filled three or four pails.

His object in bringing these finds before the Society was twofold :—to notify the members as to the localities of these forms, and to place on record the enormous size the cœnœcia some-

times attain under favorable circumstances. Prof. E. Ray Lankester, *Encyc. Brit.* 9th ed. xix. 437, says, "*Alcyonella* forms massive cœnœcia of many hundred polypides, as large as a man's fist." And again, "All the genera known are British."

Mr. Walter H. Meade announced the death, on June 28th last, of Mr. William R. Mitchell, a member of the Society. The following committee was appointed by the chair to formulate suitable action in this matter: Walter H. Meade, J. L. Zabriskie and A. Woodward.

The Recording Secretary, Dr. Dean, gave notice of his intended absence for three months, and Mr. George E. Ashby was elected Recording Secretary *pro tem.*

Meeting of November 7th, 1890.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Sixteen persons present.

A communication from the New York Camera Club was read by the Secretary, inviting the Society to an exhibit of reproductions by various photographic processes.

On motion the invitation was accepted, and the Secretary was instructed to transmit the thanks of the Society for the same to the Camera Club.

OBJECTS EXHIBITED.

1. A *Pycnogonum*: by Ludwig Riederer.
2. *Obelia commissuralis* McCready: by Ludwig Riederer.
3. Pollen of Cotton Plant: by P. H. Dudley.
5. Pseudo-scorpion: by J. L. Zabriskie.
6. Nest of Pseudo-scorpion: by J. L. Zabriskie.
7. Section of Cinnabar in chalcedonic quartz: by J. D. Hyatt.
8. Foraminifera, with dark field illumination: by J. D. Hyatt.

FROM THE CABINET OF THE SOCIETY.

9. Section of Chlorite Schist from France.
10. Section of Argillyte from Wales.
11. Section of Sherzolyte from France.

Mr. Riederer described his exhibits as follows: "*Pycnogonidæ* or *Pygnogonidæ* were placed formerly by Milne-Edwards

among the Crustaceæ. At present they are placed between the mites and spiders among the Arachnida, although they possess a greater number of appendages than either, inasmuch as the males have an accessory pair of legs, used in carrying the eggs. They are small animals with a conical suctorial proboscis, and rudimentary abdomen reduced to a tubercle. They live in the sea, and crawl slowly about amongst the seaweeds. They have four pairs of very long many jointed legs, which contain tubular diverticula of the stomach and the sexual organs. They have no tracheæ, but have a well-developed heart with an aorta and several lateral ostia. Above the brain lie four small simple eyes. They have a considerably extended ventral chain, composed of several glanglia. The eggs are carried on the accessory pair of legs on the thorax of the male, until the larvæ are hatched.

"*Obelia commissuralis* is a Hydromedusa, belonging to the Polynomedusæ, or Hydrozoa. The individual polyps are joined in a colony. The chitinous tubes widen out around the head to form a cup-like hydrotheca. The head, the oral cone and the tentacles can be retracted into the hydrotheca. The generative buds arise on the walls of the proliferous individuals, which have neither mouth nor tentacles. The buds form, in *Obelia*, flat, disk-shaped Medusæ, with numerous marginal tentacles, but with eight inter-radial vesicles. The urn-shaped reproductive capsules discharge the small Medusæ, and these swim freely for some time, until they fasten to suitable places and form new colonies. The Hydromedusæ feed entirely upon animal substances, and are most common in warm seas. The free moving Medusæ are phosphorescent. *Obelia* occurs at low water mark and in tide-pools, attached to stones and seaweeds. It is very delicate and much branched, and sometimes grows five or six inches high, though usually smaller."

Mr. Zabriskie said of his exhibits: "The Pseudo-scorpions are distinguished from the true scorpions by the absence of a tail and by a difference in the mode of respiration. They are related to the spiders, spin a web for protection during moulting and hybernating, and are classified with the Arachnida. They have two pairs of pincers: a large pair, the palpi, extending on either side, and a small pair, the falces, lying close together in front of the head.

"The nest here exhibited was found in February, 1884, with the occupant dead therein, it having died in the act of moulting This nest is composed of an oval cocoon-like web, flat and very delicate on the under side, convex and firmer on the upper side, and strengthened all around the margin by glued fragments of sawdust.

"In August, 1884, two house-flies were observed alighting at a dish of fly-poison, each fly having a living pseudo-scorpion clinging to a middle leg with a firm grip of the palpus. The flies made exertion to brush off their antagonists, but when the flies rested the scorpions would take a fresh and firmer hold."

Mr. Hyatt stated that it was unusual to find cinnabar in quartz. In his section, here exhibited, there was an appearance as of free quicksilver. Mr. Hyatt also further described the construction and operation of his substage condenser as noted at the last meeting, and with which he secured the dark field illumination for his exhibit of Foraminifera.

This led to a discussion on condensers, which was participated in by Mr. C. S. Shultz and others.

Mr. F. W. Leggett announced that he had kept for two weeks fiddler crabs in fresh water, where the crabs had been accidentally introduced, and that the creatures appeared to be thriving. This opened a discussion, participated in by Dr. Hoffmann and Messrs. L. Riederer and A. Woodward.

Meeting of November 21st, 1890.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Twenty-four persons present.

The chair appointed the following committee on Nomination of Officers: Messrs. F. W. Devoe, William G. De Witt and Walter H. Mead.

Mr. William Beutenmüller read by title a paper, entitled "Bibliographical Catalogue of the described tranformations of North American Coleoptera." This Paper is published in the present number of the Journal, p. 1.

OBJECTS EXHIBITED.

1. *Amœba proteus*: by George C. F. Haas.
2. *Euglena viridis*: by J. D. Hyatt.
3. *Epistylis* sp., from *Belostoma*: by J. L. Zabriskie.

4. *Clathrulina elegans :* by STEPHEN HELM.

5. *Actinosphærium Eichhornii :* by STEPHEN HELM.

Mr. Stephen Helm, of 417 Putnam Avenue, Brooklyn, N. Y., addressed the Society on "The Protozoa." This address opened with an exhibit and explanation of the collecting apparatus employed by Mr. Helm, and was illustrated by numerous enlarged and beautiful diagrams, and by reference to the objects exhibited under the microscopes.

PUBLICATIONS RECEIVED.

The Microscope : Vol. X., Nos. 9, 10 (September, October, 1890).

The American Monthly Microscopical Journal : Vol. XI., Nos. 9–11 September–November, 1890).

Natural Science Association of Staten Island : Proceedings ; Meetings of October 9th and November 8th, 1890.

The Microscopical Bulletin and Science News : Vol. VII., No. 4 (August, 1890).

The Botanical Gazette : Vol. XV., Nos. 10, 11 (October, November, 1890).

Bulletin of the Torrey Botanical Club : Vol. XVII., Nos. 10, 11 (October, November, 1890).

The Journal of Mycology : Vol. VI., No. 2 (September, 1890).

Psyche : Vol. V., Nos. 172–174 (August-October, 1890).

Insect Life : Vol. III., Nos. 2, 3 (September, November, 1890).

Entomologica Americana : Vol. VI., Nos. 10, 11 (October, November, 1890).

Anthony's Photographic Bulletin : Vol. XXI., Nos. 19–22 (October 11–November 22, 1890).

The West American Scientist : Vol. VII., Nos. 53, 54 (September, October, 1890).

Bulletin of the American Museum of Natural History : Vol. III., No. 1 (June, 1890).

New York Academy of Sciences : Annals, Vol. V., Nos. 4–8 (March–July, 1890) ; Transactions, Vol. IX., Nos. 3–8 (December, 1889–June, 1890).

Journal of the Cincinnati Society of Natural History : Vol. XIII., No. 2 (July, 1890).

Kansas Academy of Science : Transactions, Vol. XII., Part 1 (1889).

Boston Society of Natural History : Proceedings, Vol XXIV., Parts 3, 4 (May, 1889–April, 1890)

Bulletin of the Essex Institute : Vol. XXII, Nos. 1–3 (January–March, 1890).

Elisha Mitchell Scientific Society : Journal Vol. VII., Part 1 (January–June, 1890).

Massachusetts Horticultural Society : Transactions, 1889, 1890.

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Michigan Agricultural Experiment Station : Bulletins 65, 66 (August, September, 1890).

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Report of the Microscopist, United States Dept. Agriculture (1889).

The Indiana Medical Journal : Vol. IX., Nos. 4, 5 (October, November, 1890).

The Brooklyn Medical Journal : Vol. IV., Nos. 10, 11 (October, November, 1890).

The Hahnemannian Monthly : Vol. XXV., Nos. 10, 11 (October, November, 1890).

The Satellite : Vol. IV., Nos. 2, 3 (October, November, 1890).

The American Lancet : Vol. XIV., Nos. 10, 11 (October, November, 1890).

Mining and Scientific Review : Vol. XXV., Nos. 13–21 (September 25–November 20, 1890).

The Pacific Record of Medicine and Surgery : Vol. V., Nos. 3, 4 (October, November, 1890).

Johns Hopkins University : Studies from the Biological Laboratory, Vol. IV., No. 7 (October, 1890) ; Circulars, Vol. X., No. 83 (November, 1890).

National Druggist : Vol. XVII., Nos. 7–9 (October 1–November 1, 1890).

The Electrical Engineer : Vol. X., Nos. 126–134 (October 1–November 26, 1890).

Journal of the Royal Microscopical Society : 1890, Part 5.

The Journal of Microscopy and Natural Science : Vol. III., No. 4 (October, 1890).

The Naturalist : Nos. 183, 184 (October, November, 1890).

Bristol Naturalist's Society : Proceedings, Vol. VI., Part 2 (1889, 1890).

Penzance Natural History Society : Transactions (1890).

The Ottawa Naturalist : Vol. IV., Nos. 7, 8 (October, November, 1890).

The Victorian Naturalist : Vol. VII., Nos. 4, 5 (August, September, 1890).

Royal Society of New South Wales : Journal and Proceedings, Vol. XXIII., Part 2 (1889).

Société Belge de Microscopie : Bulletin, Vol. XVI., Nos. 8–10 (1890) ; Annales, Vol. XIII., No. 3 (1890).

Nuovo Giornale Botanico Italiano : Vol. XXII., No. 4 (October, 1890).

Malpighia : Vol. IV. (April, 1890).

La Nuova Notarisia : Padoue (August, October, 1890).

Notarisia : Venezia, Vol. V., No. 20 (August, 1890).

Bollettino della Societa Africana d'Italia : Vol. IX., Nos. 7, 8 (July, August, 1890).

Wissenschaftlichen Club in Wien : Monatsblätter, Vol. XI., No. 12, Vol. XII., No. 1 (September, October, 1890).

Société Royale de Botanique de Belgique : Comptes-Rendus (October 11, 1890).

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Société Impériale des Naturalistes de Moscou : Bulletin, Vol. III., No. 4—Vol. IV., No. 1 (1889, 1890).

Sociedad Cientifica "Antonio Alzate" : Memorias, Vol. III., Nos. 7–10—Vol. IV., Nos. 1, 2 (January–August, 1890).

Revista del Museo de La Plata : Vol. I. (1890).

Le Diatomiste : Nos. 1, 2 (June, September, 1890)

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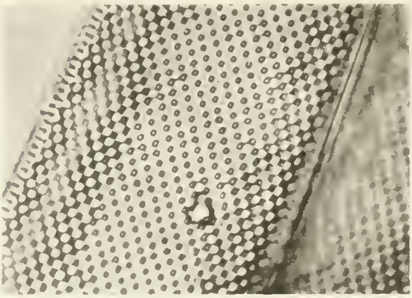

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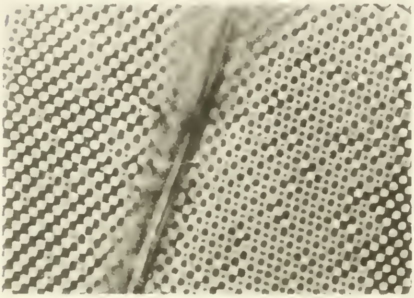

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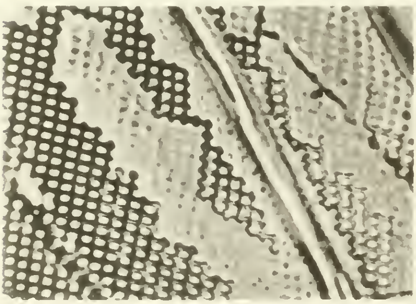

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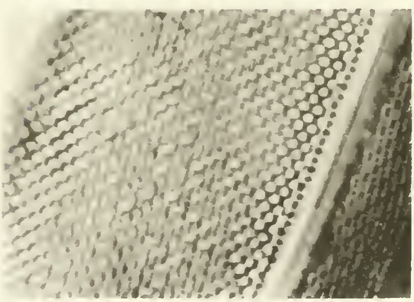

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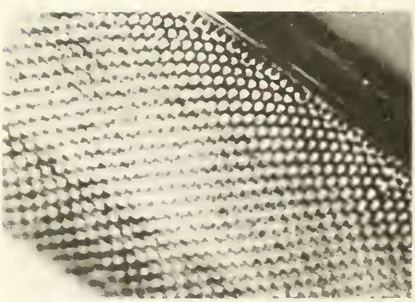

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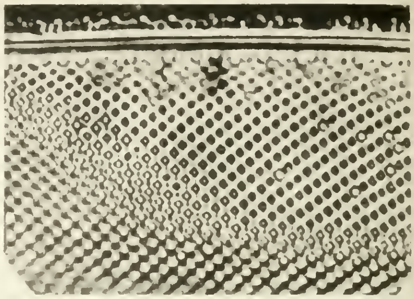

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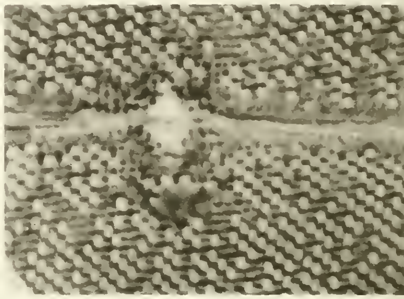

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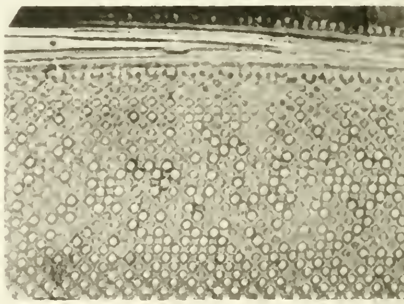

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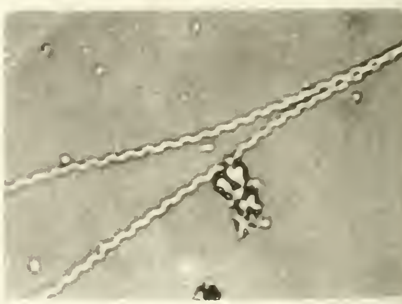

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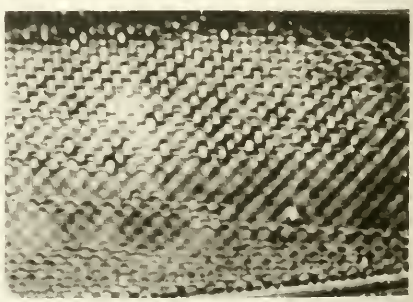

T. F. SMITH ON THE STRUCTURE
OF THE
PLEUROSIGMA VALVE.

JOURNAL

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NEW-YORK MICROSCOPICAL SOCIETY.

VOL. VII. APRIL, 1891. No. 2.

ON THE STRUCTURE OF THE PLEUROSIGMA VALVE.

BY T. F. SMITH, F.R.M.S.

(*Read January 2d*, 1891.)

On September the 28th, 1888, I had the honor of reading before the Quekett Club a paper bearing the above title, in which I attempted to prove that the supposed single plate of silex forming the pleurosigma valve was, in reality, built up of two or three layers of structure.

That this idea of mine was not a new one I subsequently discovered and admitted in a paper on the same subject, read by me before the Royal Microscopical Society, in which I quoted the remarks of Herr Grunow and Mr. Kitton on the subject. I also have taken the opportunity in this paper of bearing testimony to the labors of Dr. Jacob D. Cox in working out the structure of the diatom-shell; who, although he makes no positive statement on the pleurosigma valve, says that certain appearances are "not inconsistent with a double structure."

Incidentally I may say that after arriving at a certain stage of my work I searched through the collections of photographs of diatom-structure belonging to the Royal Microscopical Society, and found Dr. Cox's prints of *P. angulatum* to be the only ones giving a correct rendering of one of the layers—the one shown in my slides Nos. 35, 36, and 37 of that diatom.

The reason is very simple: This layer can only be distinguished from the one on the other side of the valve by the use of a large cone of light; and having so distinguished it, I think America can

claim in Dr. Cox the first worker in photomicrography under those new, and the only true, conditions.

But, while making no claims now to be the first to originate this idea of a compound structure in the finer forms of diatoms, I think I may claim to have been the first to attempt to photograph the different layers; not from possessing any superior powers of observation, but because the work was only possible after the advent of the new apochromatic lenses from Germany.

When we consider the difference between the actinic and the visual foci in the best lenses of the ordinary achromatic correction when used photographically, and also the infinitesimal distances which must separate the different layers in the valves of the minute forms of diatoms, it will be seen at once how utterly impossible it would be to make any allowance fine enough to bring the particular layer aimed at sharp in focus on the negative. The reduction, however, of the secondary spectrum in the apochromatics entirely obliterates this difference, and what is seen sharp on the focussing screen may be depended upon to be sharp in the negative, given correct exposure and development.

This capacity of standing more light was pointed out from the first by Mr. E. M. Nelson, but has not received the attention it deserves; and the neglect of this point has stultified the efforts of many microscopists, both here and on the Continent, to get more out of the new glasses than the old objectives. Unfortunately, the most flagrant examples of "how not to do it" come from the very workshop which produces the glasses, and Dr. Roderick Zeiss' celebrated print of *P. angulatum* shows how an oil-immersion apo: of 1.3 N. A. may be made to perform no better than a good dry ¼-inch.

The conclusion arrived at in my first paper is that the valve of *P. formosum*—as being the one most easily studied from its coarse structure—consists of three layers, figured as Nos. 1, 2, and 5 in the plate belonging to that paper.

The figures may still be taken as correct representations of the layers, but I am afraid this is the only part not rendered obsolete by subsequent observations by myself, and most of the theories proposed there must be thrust aside as crude deductions from imperfect observations. The figures of *P. formosum* may stand, but that given of the middle layer is not the middle layer at all

in the sense of its occupying the centre of the section of the valve. To understand its position it must be remembered that in section the valve is V-shaped (Fig. 1); No. 1 being the inner, No 3 the extreme outer side of the valve, and No. 2 immediately under No. 3, and optically, but not structurally, a part of it. When I say optically a part, I mean that had I not seen them separated I should never have ventured to declare them different layers. Nos. 1 and 2 are comparatively robust in structure, while No. 3 is exceedingly fragile and often seen lying in strips on the face of the valve; and it is from the fact that under these circumstances No. 2 is still found sound I have been able to differentiate the two. This difference of curve between the two sides of the valve is seen to run through all the species of *Pleurosigma*, although in none of them are they so pronounced in character as in *P. formosum*. This difference always corresponds with a difference of

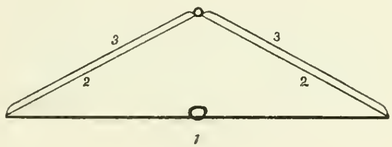

Fig. 1.

appearance, and although I do not believe the variation, structurally, between the two sides of some of them is much, it must be enough to account for the difference.

The first four of the series of lantern slides sent to illustrate this paper are numbered 1, 2, 3, and 4, and represent the three layers of the valve of *P. formosum;* Nos. 1 and 2 being taken from the inner side and showing it to be nearly flat in section. The structure of this layer seems to be a square grating set lengthways on the valve, and its peculiarity is that on the same plane the focal images are formed in the alternate squares of the grating only, giving the usual appearance of the diagonal markings. On the outer focus the alternate holes are red, the interspaces white, as in slide No. 12; but on focussing inward the white interspaces turn into green "beads," and the outer red interspaces become white. This red and green is not merely a negative and positive image of the same structure, but formed in entirely

different positions (Fig. 2), the "×" marking the red, and the "o" the green. Taking note of the difference of the colors in the alternate holes of a grating may seem trivial to a biologist marking out, say, the life history of some obscure organism, but in reality it points out a valuable quality belonging to an apochromatic lens only and helping to call attention, in all branches of microscopic research, to points which else might escape attention. I say this advisedly, having tested some of the finest glasses of our English makes, but not apochromatics, on this object; and although the two sets were shown in their proper positions, they were both of the same color, and thus the different positions likely to escape notice. I have not yet been able to discover the cause of the two sets of images in this layer. There is no difficulty about the outer red ones being simply the alternate holes of the grating; but I can find no cause for the inner green

O	X	O	X	O	X	O	X	O	X	O	X
X	O	X	O	X	O	X	O	X	O	X	O
O	X	O	X	O	X	O	X	O	X	O	X
X	O	X	O	X	O	X	O	X	O	X	O

Fig. 2.

"beads," although it may point to a second grating inside on which they are received as on a screen.

The difference of appearance between the two sides of the valve is most characteristic and one not to be mistaken when once seen and noted, and is well shown on slides Nos. 12 and 13—No. 12 being the inner and No 13 the outer side of the valve.

As I have said before, the structure of the outer part of the valve is really divided into two—Nos. 2 and 3 in Fig. 1—but it is with the outer one of the two, as offering numerous examples of torn structure, we have chiefly to deal. I have been able, fortunately, to determine its character with absolute certainty, and also probably to obtain a key from it of the structure of the other two layers of the valve; but the results I propose to lay before you are so little in accordance with any theory of structure hitherto accepted by diatomists, that I can well understand any reluctance there may be to receive them as true. I certainly should have hesitated to accept them myself, had they not been forced

upon me by the continual work of nearly three years in a manner which left me no room to come to any other conclusion. My state of mind on beginning to work on a dry slide of *P. formosum* was one of utter bewilderment at the variety of appearances presented by the different valves, and my first impulse was not only to throw up the work, but also the microscope, in disgust, as giving no image of any structure which could be depended upon. After a time, however, I began to classify the appearances by observing that it was different sides of the same diatom presented to me, and, given the same side, the same appearance. After this my work became easy, and all my subsequent work a natural outgrowth from the labors preceding.

In coming before you with a brand-new theory of diatom-structure—as far, at least, as the *Pleurosigma* are concerned—I know the difficulties of the subject; how easy it is to mistake interference phenomena for new structure; how even the assumption by me of different layers would put me out of court on the laws

FIG. 3.

of these phenomena alone, did I attempt to base my theory on these appearances only. But I have made no such attempt, have never assumed the truth of any appearance until I have examined the structure causing it, by seeing it isolated from anything above or below. This I have been fortunate enough to do in numerous instances, and, after you have seen the results on the screen, will leave it with confidence to your judgment to decide whether I have been deceived in my conclusions or not.

The ultimate structure of the outer layer of the outer, or convex, side of *P. formosum* is seen in slide No. 9, and consists of a long fibril subdivided into short bars (Fig. 3), but how joined together I have not been able to discover. These fibrils are placed side by side lengthways on the valve, and run from end to end, and when perfect the appearance is as in Fig. 4, as plainly shown around the nodule in slide No. 11. When the structure is perfect, a white focal "bead" is formed in each of the larger interspaces and the whole run diagonally across the diatom, as in slides Nos. 5 and 13. On focussing inward you lose the bright

spots and come upon a grating running diagonally across the valve—as in slides Nos. 3, 6, and 8—and it will be seen that the holes of the diagonal grating lie immediately under the larger interspaces left between the fibrils. I believe these round white patches to be only ghosts, or, in other words, images of the inner layer thrown on the outer as on a screen, in proof of which I submit slides Nos. 7 and 8. In No. 7 the fibrils are distinctly seen running parallel to the median line, but only some of the interspaces are filled up, and on focussing down you discover the cause. In the under layer the holes are irregular in size, and it is only from the larger ones that the images are thrown. The outer layer often appears as if formed of definite squares, but I have no reason to believe there are any actual cross-bars, for directly the torn fibrils begin to diverge from each other, as in parts of slide No. 11 already referred to, cross-lines disappear.

FIG. 4.

There is nothing to say, that I know of, against the idea of a regular grating; but when we get positive evidence to the contrary, a merely reasonable interpretation of appearances must give way to actual fact. It may be easily seen, however, on referring again to Fig. 4, how an appearance of cross-lines may be brought about.

Having done my best to establish the nature of the structure of the different layers of *P. formosum*, it remains to see how far the structure of the valves of the minute forms of this genus are identical with it. Similarity of form in itself should almost be enough to establish a unity of structure, and it satisfied myself a long time before I had obtained positive evidence to support it. But proof to one's self does not mean proof to others, and it was necessary to complete the evidence by offering sufficient examples of torn structure from each typical species to prove the identity. But before going on to this I would mention a few salient points common to all the *Pleurosigma*, and which hitherto seem to have

escaped attention. There is first the difference of curve between the two sides of the valve—flat on the inner and convex on the outer—common to all, and with it the different appearance presented optically; secondly, all the valves of this species characterized by diagonal "markings" have a row of coarser perforations running parallel to the margin of the valve, and also a row of similar ones on each side of the median line, making altogether four rows on the face of each valve; and, lastly, the nodule shows a characteristic difference on the two sides of the valve. On the one side it seems simply a cavity with the larger perforations running around, while on the other side it seems to be formed as a ring connecting the two halves of the median line. The four parallel rows, however, of larger perforations present the most characteristic features in common, and many of the specimens thrown on the screen from *P. formosum* downward will show them distinctly.

The finer specimens will mostly explain themselves, coming after *P formosum*; for convenience of comparison with which I have taken some of the latter at half the number of diameters, that the detail may appear of about the same minuteness as the finer forms. Except that of *P. angulatum*, all my negatives have been taken from two slides of *P. formosum*, and for a long time I was unable to get any positive evidence of the finer structure of *P. angulatum* much different from the usual appearance, although there was no doubt about its resemblance in the general features to the coarser forms. But latterly I have been more fortunate, and am able to present a series of slides of that diatom which establishes beyond a doubt the identity of its structure with the other forms of the genus to which it belongs. Altogether, then, we have examples of four different species, differing vastly in size and shape, but in the finer structure all present the same features. I admit that examples of torn structure in the last three typical forms, although numerous enough to prove my point, do not offer the same extent of torn surface to study from as *P. formosum*; but, under certain circumstances, this would be scarcely possible. *P. formosum* has the structure twice as coarse as the other forms, and the mechanical pressure exerted on them in mounting being the same in both cases, what would be sufficient force to separate the fibrils only, and still leave them sound in the one, would

simply, in the others, smash them into bits so small as to be useless for purposes of investigation.

This is so generally; but in places enough of the structure is left intact to establish its identity, and I need not say that, having once found out what a chain is, there is no difficulty afterwards in proving that a link is a part of a chain, even if we can find no more than that link. In *P. formosum*, as we have seen, we find whole chains; in the finer forms only occasional links, but unmistakably belonging to the same sort of chain.

The first slides of *P. angulatum*, Nos. 35, 36, 37, and 38, are taken (three of them across the nodule) to show the different curves of the two sides of the valve; Nos. 35. 36, and 37 being from the inner side, and No. 38 from the outer. It will be seen that on the inner side the surface starts straight from each side and curves down towards the median line, while the outer starts straight from the median line and curves down towards each margin. The outer, or convex side, like the corresponding side of *P. formosum*, is the one from which all my torn examples are taken, and is absolutely identical in character; but beyond *P. decorum* I have been unable to discover any diagonal layer immediately underneath. The non-discovery of this may be due to two reasons: it may not exist at all, or the two may be so close together that even the little depth of focus of a wide aperture may be too much to allow them to be separated, in which case they would be microscopically non-existent. I have made experiments to this purpose on *P. formosum* with a dry apochromatic $\frac{1}{4}$-inch of .95 N. A, and found that the torn structure could not be seen with it when lying at the usual distance above the valve, but when the valve had sunk down—increasing the normal distance between the two layers—they could be seen readily enough; indeed, when floated off the valve altogether they could be seen with a one-inch of very moderate angle. I can offer no evidence, therefore, of the existence of a double layer on the outer side of the finer forms, although analogy may tell us there should be one, and must leave it at present as not proven.

The first two slides of the inner side, Nos. 35 and 36, taken on the same spot, will give you both squares and hexagons, and you must take your choice between them; for, having no exam-

ples of torn structure from that side of the valve, beyond a notched edge, I do not care to speak absolutely. Other examples, however, from the outer side, will show you how hexagons can be made, and you can form your conclusions accordingly.

Slides Nos. 40, 41, and 42 are taken at different focal planes on the same valve, which shows the surface abraded and two isolated fibrils running lengthways on the valve. The difference of appearance on the sound parts is considerable and varies from long rectangles on the upper focus to decided hexagons on the lower, while the only difference it makes on the fibrils themselves is just to thicken them a little. The same thing happens also on slides Nos. 47 and 48, taken with a little difference of focus, where we have squares on the upper and hexagons on the lower, while the free ends of the torn fibrils suffer but little change.

All my remarks up to now apply to the species having diagonal "markings" only; but the last slide of the list is taken from *P. balticum*, as an attempt to give a general idea of the difference of the structure between the two. Here we have still fibrils, but apparently of one continuous strand with swellings at regular intervals, which, lying side by side of the others, with the knobs nearly touching, give the appearance of squares.

In conclusion it may be necessary for me to say something about my methods of investigation, that no outstanding doubts may be left as to the correctness of my conclusions. This is all the more binding on me, as Dr. Cox has kindly told me that "I had need to tell the details of my examination so fu ly as to repel the possibility of doubt that the matter is in no sense illusory." I accept the invitation most cordially, as every practical microscopist will know that the method of investigation is everything.

First, as to illumination: I use a strictly central cone of light, collected first from the edge of the lamp flame by a bull's-eye condenser before being further condensed by the achromatic condenser. In this way I get a more intense illumination. Indeed, I found it impossible to differentiate some of the structure without it. My achromatic condenser is a dry one, and with the bull's-eye will give me all the light the lens will stand. In theory, of course, the whole of the aperture can only be utilized by the aid of an oil-immersion condenser. Granted the back lens of the combination can be only filled that way; but the

objective which can be so used without breaking up the image has yet to be made, in Europe at least.

The slides from which I have taken my examples are two slides of *P. formosum* and one of *P. angulatum*, mounted dry by Möller ; but I have verified my observations on a type-slide of *Pleurosigma* mounted by Thum, also on dry mounts by the same mounter and on a slide of *P. formosum* mounted in phosphorus by Mr. Stephenson, F.R.M.S., to prove there is nothing abnormal about the structure.

All my specimens have been tight on the cover, that the full available aperture of the lens might be used on them ; and in some instances, when there has been a doubt raised by others whether some of the appearances might not be due to some of the objects being off the cover, they have been tested by the vertical illuminator.

I have never taken a single photograph of any structure without thoroughly working it out visually first, that every point might be known to me before attaching the microscope to the camera ; and each hour's work there means six hours at least of previous investigation.

The question is sometimes asked, "What is a true focus ?" and I admit that without certain landmarks the question is a puzzling one, as the image will keep repeating itself both in and out of focus. But to me those landmarks always exist, and in the structure I have been working at will be found in the leading features, such as the median line and the rows of larger perforations I have before mentioned. Thus, in comparing slides Nos. 35 and 38, the former gives what Mr. E. M Nelson calls the black dot, and the latter the white dot ; but a little higher focus on each will reverse them. The question then comes in, Which is right ? and the answer is found in the median line with its two rows of perforations in one case and the margins in the other. In both cases you can reverse the image by raising the focus, but at the same time you lose the salient points of the valve. But, quite apart from this, there is a crispness and brightness about the image when at the true focus which cannot be mistaken by an expert.

The image of diatom-structure with an apochromatic is absolutely colorless, making the slides exhibited a true rendering of the appearances in the microscope—that is, with all the upper

layers; but where I have taken an under layer on the same valve, air comes between and the image has suffered—will, in fact, be recognized by you at once by its dull tone, and I wish you to draw no other inference from it but to see that there is another structure underneath.

On the slide No. 34 will be found in the centre a single layer of a fine species allied to *P. angulatum*, and at the side a part, I believe, of the same valve with the both layers intact ; and a study of the changes which take place in both on focussing up and down enables me to draw certain deductions, for my own guidance at least.

In the single layer there are no changes whatever beyond a change from a positive to a negative image up and down, and then the object vanishes altogether ; but on the other fragment there are six changes at least, proving the structure to be more complicated.

It will then, I think, be safe to argue that when the object under investigation changes from more than a positive to a negative image ; when, after losing, or almost losing it, you come upon another distinct image, either higher or lower, it proves this, at least : that the structure you are examining is a compound one, although I need not argue from it that the appearance you get is necessarily the true one.

The inference I would draw, then, from certain appearances on the surface, would be a limited one, but within those limits to be trusted. Thus, where you see squares or hexagons, it is not necessary that there should be squares or hexagons in the structure ; but it may be safely inferred that the recurring distances of the image represent the true distances of the actual structure. There is, in fact, with any legitimate use of the objective, no doubling and trebling of the lines as represented in influential quarters, but a correct rendering of distances if within the resolving power of the aperture, as shown by me in my "Note on the Abbe Diffraction Plate," published in the July number of the *Quekett Journal* for 1889.

Knowing my Abbe Diffraction Plate well, then, I have come to no conclusions on appearances only, and have formed no definite opinions on any structure until I have seen it isolated ; and can leave the results with all the more confidence in your hands.

LIST OF LANTERN SLIDES REFERRED TO IN THE PAPER "ON THE STRUCTURE OF THE PLEUROSIGMA VALVE."

BY T. F. SMITH, F.R.M.S.

1. *P. formosum.* Inner side of valve seeming to consist of a square grating, in which, when perfect, a focal image is formed in the alternate squares. × 1750.

2. The same. Same side, but another valve—one of the sides, from the margin inward, shows appearance when perfect. × 1750.

3. The same. Layer immediately under No. 4 on the outer side of valve, and seems to consist of a robust diagonal grating. × 1750.

4. The same. Layer immediately over No. 3, above the median line. The under structure has sunk down, leaving the long triangular bit adhering to the cover. × 1750.

5. The same. Layer on the outer side of the valve, sound. × 1750.

6. The same. The diagonal grating immediately under, sound. × 1750.

7. The same. Same layer as No. 5, but images showing in patches.

8. The same. Grating immediately under showing cause of patchiness. The holes in under grating are either some of them stopped up, or all the parts of the grating are not on the same level.

9. The same. Ultimate structure of layer No. 4, consisting of short bars of silex arranged as an irregular fibril. × 1750.

10. The same. Ultimate structure arranged on the valve, but stripped off in places. The diagonal lines represent the No. 3 grating underneath, out of focus. Note how the bright focal spots are caught between the fibrils. × 1750.

11. The same. Same structure arranged to form squares around the nodule. It will be seen that in some places the appearance is that of a square grating with well-defined cross-bars, but when the fibrils diverge from each other the cross-bars are lost. I am inclined to think the cross-bars an optical illusion. × 1750.

12. The same. Inner side of valve, same as No. 1, magnified 875 times only, that the detail may appear of the same size as the smaller species, such as *P. angulatum.* This valve is perfect and does not show the grating except at one edge. On focussing inward all the white interspaces form into green "beads." × 875.

13. The same. Outer layer, same as No. 4, perfect. Median line appears at the edge, but on focussing down that part of the valve is seen shelving down, showing the outer side of the valve to be V-shaped in section. × 875.

14. The same. Torn structure from same side, some of which has floated off from the valve altogether. Note the diagonal lines underneath. × 875.

15. *P. angulatum* (?). Same side, but another valve. Note fibril where marked with a cross, to compare with same structures on finer specimens. × 875.

16. *P. decorum.* Outer side. Underneath is the same diagonal grating, which I have not figured. × 1750.

17. *Pleurosigma* sp. Small species shown where marked with a ×. This is the species from which the next nine slides are taken.

18. The same. Under layer, with a hole clean through in one part. × 1750.

19. The same. Same valve, outer layer, with fibrils projecting over part of hole. × 1750.

20. The same. With torn fibrils, outer layer. × 1750.

21. The same. Under layer of same valve, showing long strip and hole torn out, which the fibrils shown on No. 20 have bridged over. × 1750.

22. The same. With bit chipped off the edge and fibrils lying loose. × 1750.

23. The same. With fibrils unravelling. × 1750.

24. The same. Another part of same valve. × 1750.

25. The same. Surface abraded, and showing fibrils on parts of valve. × 1750.

26. The same. Inner side of valve, corresponding to No. 1 layer of *P. formosum.* × 1750.

27. *Pleurosigma* sp. Specimen marked with a ×, and the same species from which the next six slides are taken.

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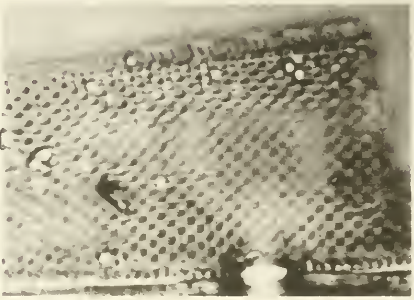

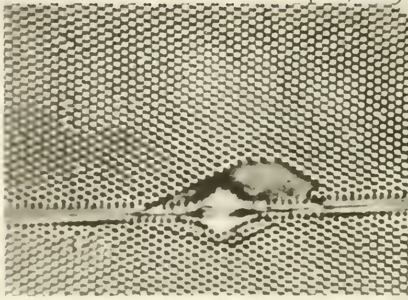
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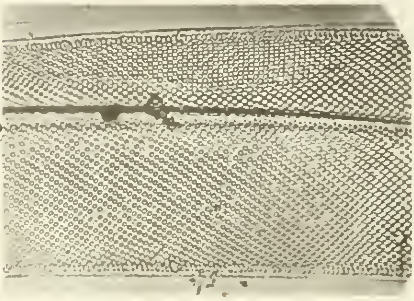


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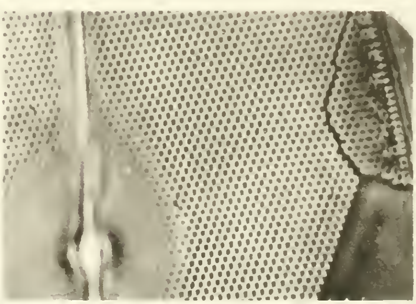


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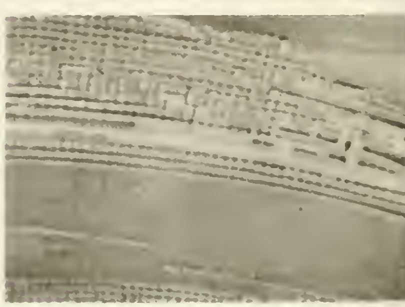
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T. F. SMITH ON THE STRUCTURE
OF THE
PLEUROSIGMA VALVE.

28. The same. Outer side with torn structure. × 1750.

29. The same. Layer immediately underneath. × 1750.

30. The same. Showing the two layers at one view. × 1750.

31. The same. Layer underneath. × 1750.

32. The same. Outer layer, showing fibrils, perfect but only occasional focal images. × 1750.

33. The same. Layer underneath. × 1750.

34. *Pleurosigma* sp. Single under layer of a fine species of a *Pleurosigma* detached from the outer. At the side will be seen a part of the same valve, I believe, with the both layers complete.

35. *P. angulatum.* Inner side, showing curve straight from each margin and sloping down towards the nodule and median line. This plane shows square. × 1750.

36. The same. Same part taken at a little lower level to show hexagons and intercostals. × 1750.

37. The same. Same side, but another valve. × 1750.

38. The same. Outer side, showing curve straight from nodule and median line, and slopes down towards the margins. N. B.—Structure on this side corresponds to No. 4 slide of *P. formosum.* × 1750.

39. The same. Same side, showing longitudinal crack with fibril bridged across it in one place. × 1750.

40. The same. Surface abraded and two fibrils left isolated. × 1750.

41 and 42. The same. Same spot, but at a little lower focus to show changes in appearance on sound parts of valve. The changes on the surface are considerable, while the fibrils themselves change but little, except to thicken. The last is the lowest of the three and the appearance hexagonal. × 1750.

43. The same. Same side, showing—where marked with a ×—two fibrils joining together to form the regular structure. × 1750.

44. The same. Same side—end of valve—shows isolated fibrils in places. × 1750.

45. The same. Same side, torn structure. × 1750.

46. The same. Slide of *P. angulatum.* The specimen marked with a × is the one from which the next three slides are taken.

47. The same. Torn structure, showing free ends of fibrils.

48. The same. Same bit taken at a little lower level to show hexagons on sound parts. Note that but little change has taken place in the torn part, on account of there being no interference from structure below. × 1750.

49. The same. Same valve, showing under layer. The part immediately under the torn structure has been torn off and pushed down, leaving a considerable distance in that place between the two layers. × 1750.

50. *P. balticum.* The fibrils here seem to be in long strips and thickened out at regular intervals, giving the appearance, where they approach each other, of a square grating. Indications also are given on the slide of the lower layer. × 1750.

DIATOM-STRUCTURE—THE INTERPRETATION OF MICROSCOPICAL IMAGES.

BY JACOB D. COX, LL.D., F.R.M.S.

(*Read January 2d,* 1891.)

Mr. Smith's paper and his photographs are a valuable and interesting contribution to the discussion not only of diatom-structure, but incidentally of the interpretation and value of microscopical images.

The discussion of the structure of the diatom-valve turned, for a long time, on the question whether the dotted markings were caused by solid spherules or hemi spherules of silex or by areolæ or alveoli in the shells. Elaborate rules were formulated by which it was supposed the examination should be so conducted as to decide indisputably when a dotted appearance was caused by the one or the other structure. The study of the fractured edges of broken shells, aided and illustrated by photography, may be said to have settled this question in favor of the alveolar structure some years ago. This done, we were prepared for the next question, which was whether these alveoli are capped by a very thin silicified film on one or on both sides of the shell. Are they or are they not cellules in the shell, completely enclosed by a silicified membrane? Without asserting that this is definitively settled, it may fairly be said that the prevalent opinion now is that the alveoli are thus completely enclosed, but that the extremely thin membranous caps are not so solidly silicified but that endosmose acts through them and the plant is nourished in this way.

The next step in the discussion is the inquiry whether the alveoli are interior cavities in a single homogeneous membrane, or is the shell formed of two or more membranes. In the more robust kinds it was demonstrated that there were at least two plates or membranes in the shell. The larger *Coscinodisci* were often found with the inner film, containing the so-called "eye-spots," separated from the outer part of the shell; this inner film being much thinner than the outer, and nearly flat, the shallow depressions at the eye-spots being surrounded by a hexagonal tracing which marked the place where the walls of the comparatively deep cellules had been attached. The outer film or plate consists, apparently, of stout hexagonal structure capped on the outer side. In several species this outer side has a secondary marking of finer dots within the larger hexagons. In *Triceratium favus* the *inner* film is that which has the secondary marking, consisting of very fine dotted lines radiating from a common centre and continuous over the whole shell. There can be little doubt that these finer, secondary dots are analogous to the larger ones and are indications of a pitted surface. In these coarser forms it is quite conceivable that the structure should consist of three plates, viz., an outer and an inner plate, each nearly flat,

and an intermediate one consisting of a hexagonal grating or a plate perforated with holes. The three in apposition would constitute the shell with its alveoli. As a matter of fact, I do not know that more than two such plates have yet been discriminated as components of the diatom-shell, and my present belief is that there are but two, unless Mr. Smith's investigations shall establish a third. As I understand his observations, they are consistent with the foregoing general theory of the shell-structure, and are the basis for a theory of a fibrous film exterior to those above described and superposed upon them. To this I shall presently return.

That the structure of the diatom-shell is the same in very thin and finely marked species as in the more robust, has always seemed probable to investigators, and the argument from analogy has been used with confidence. This, however, has not been allowed to discourage the study of the finer forms, and the improvement of our glasses has been utilized by bringing finer and finer details under direct observation. The separability of the shell into two plates has been noted not only in small and finely marked *Coscinodisci*, like *C. subtilis*, but in the *Actinocycli*. In *Pleurosigma* (*P. formosum*, *P. angulatum*, and *P. balticum*) the broken margin showing what Mr. Smith calls the "postage stamp" fracture has been seen and photographed, and in a number of photomicrographs of my "broken-shell series" (June, 1884) I showed this and what I regarded as separated upper and lower films of the valve of *P. angulatum* in the same specimen.*

Such being the state of our knowledge and theory on the

* In a summary at the end of a series of articles on "Structure of the Diatom-Shell" in the *Am. M. M. J.* (March to June, 1884) I said, p. 109:

"1. The diatom-shell is usually formed of two laminæ, one or both of which may be areolated, and may be strengthened by ribs, which have been described both as costæ and as canaliculi.

"2. The normal form of the areolæ is a circle, and these when crowded together take a hexagonal and sub-hexagonal form.

"3. The areolæ are properly pits or depressions in the inner surface of one of the laminæ, so that when two laminæ are applied together the exterior surfaces of the shell thus formed are approximately smooth and the cavities are within.

"4. The apparent thickening on the exterior of the lines bounding the areolæ in some species, as *Eupodiscus argus*, etc., is not in contravention of, but in addition to, the formation above described.

"5. However fine the marking of diatom-valves may be, the evidence from the color of the spaces between the dots and of the dots themselves supports the conclusion that they follow the analogy of the coarser forms, in which both fracture and color are found to prove that the dots are areolæ and the weaker places in the shell."

subject, Mr. Smith determined to try what could be learned by the systematic and careful use of the Zeiss apochromatic lenses under such conditions as to sub-stage illumination, by means of a wide-angled condenser, as should give the new objective the fullest scope for its power and quality. His conclusions from this examination he has kindly laid before us, so fully illustrated by beautiful lantern slides and prints that we can have little doubt as to the *appearances* on which the conclusions are based, except as to color.

In such a case the real question is one of interpretation of appearances seen under the microscope, and what I have to say will bear chiefly on this point, with direct application to the study of diatoms.

All microscopists are acquainted with the position of Prof. Abbe in regard to images formed by diffraction. As commonly stated it amounts to a declaration that all microscopical images of structure with details smaller than .0005 of an inch are diffraction images from which the true structure may be argued, but which cannot be taken as in themselves true representations of the structure. "The resulting image produced by means of a broad illuminating beam," says Prof. Abbe (*R. M. S. Journal*, December. 1889), "is always a mixture of a multitude of partial images, which are more or less different (and dissimilar to the object itself)."

This theory has been very vigorously assailed by Mr. E. M. Nelson, of London, from the practical and experimental side. In a paper read before the Quekett Club in May last, entitled "The Sub-stage Condenser: Its History, Construction, and Management; and its Effect Theoretically Considered," Mr. Nelson asserts that the cone of light from a sub-stage condenser "should be of such a size as to fill $\frac{3}{4}$ of the back of the objective with light; thus N. A. 1.0 is a suitable illuminating cone for an objective of 1.4 N. A." He says that "this opinion is in direct opposition to that of Prof. Abbe," and to maintain it he denies the truth of the diffraction theory as applied to microscopical images. He says of it: "The diffraction theory rests on no mathematical proof—in the main it accepts the physical law of diffraction; but on experiment it utterly breaks down, all criticism is stopped, and everything connected with it has to be treated in a diplomatic

kind of way" (*Quekett Club Journal*, July, 1890, pp. 124, 125). I state Mr. Nelson's position without any purpose of discussing it, and only to point out that it is this to which Mr. Smith refers in his paper when he says: "This capacity of standing more light was pointed out from the first by Mr. E. M. Nelson, but has not received the attention it deserves, and the neglect of this point has stultified the efforts of many microscopists, both here (in England) and on the Continent, to get more out of the new glasses than the old objectives."

Mr. Smith's investigation of diatom-structure is thus closely connected with Mr. Nelson's views and experiments upon the diffraction theory. Both will challenge the attention of practical microscopists as well as physicists. I have not gone far enough in my own investigations to warrant me in expressing a judgment on the questions involved ; but I would urge every microscopist to make his ordinary work the occasion for accumulating evidence which may help settle the very important debate. My suggestions are only such as are based upon the well-known history of diatom-study and my own experience. They are offered by way of clearing the field by pointing out the limits of the discussion and the known facts which ought to be kept firmly in mind in all such investigations.

It is no reproach to the microscope as an instrument of investigation that there are limits to its powers and capabilities. Such limitations are common to all methods of investigation. If, trusting to my natural eyesight, I am trying to make out the meaning of appearances on a distant hillside, I find at once that all perception by the sense of sight is an interpretation of visual phenomena which are not in themselves decisive. They may lack clearness by reason of the mist in the air. They may be obscured by something intervening, like foliage, or may be partly hidden by inequalities of surface. A thousand things may prevent clear and easy interpretation of what I see. I may have to change my point of view before I can reach a conclusion, or even have to go to the object itself. If I cannot do this I may be left in abiding doubt as to what I have seen.

Microscopical examination is precisely analogous to this. If I am examining a mounted object, I am tied to one point of view. I cannot approach nearer, and cannot do more than note the

visual appearances and make theories to account for them in accordance with facts already learned. We try to vary the conditions as much as we can ; we change our objectives ; we try central light and oblique light ; we examine one specimen dry and another in a dense medium ; one by transmitted and another by reflected light ; but when we approach the limit of minuteness of object or detail which our instruments will define, we are in the same situation as when using our natural eyes across a chasm, neither better nor worse ; we have to account for what we see by a reasonable hypothesis which will make it take an intelligible place amongst natural objects.

Our skill as microscopists, apart from the technical dexterity in the use of our tools, consists largely in devising varied experiments and changes of condition, so as to enlarge the body of evidence from which we draw our inductive conclusions. To assist ourselves in this, we also catalogue such facts and methods, and such cautions and warnings, as our experience (or that of others) has taught us. Let us look for a moment at some examples.

We know very well that we are liable to illusions of sight, so natural and so powerful that even the intellectual certainty that they are illusions will not destroy them. If we are looking through the Abbe binocular eyepiece, using the caps with semicircular openings, we see a hemispherical object as if it were a hollow bowl, and, visually, it refuses to be anything else. But this is not peculiar to microscopical vision, for we do an analogous thing with the stereoscope, and by wrongly placing the pictures may make an equally startling pseudo-perspective.

We find that what we call transparent bodies are full of lines as dark as if made with opaque paint, and throw far-reaching shadows. But I see similar ones in the cubical glass paper-weight on the table before me, and know that by the laws of refraction the surface of a transparent body is always dark when its angle to the eye is such as to cause total reflection of the light in the opposite direction. By the same law we know that if the angle of total reflection in the same transparent cube were differently placed with regard to the eye, the now dark surface would become a mirror, reflecting the sky and distant objects as brilliantly as if silvered. Our diatom-shells give us constant experience in these phenomena. A prismatically fractured edge

will scintillate so as to defy all efforts to define its outline. Reflected images look like actual details of structure in the object. Dealing, as we constantly are, with objects made of glass, we have constant use for our reasoning faculties to determine the meaning of all these refractions and reflections, which sometimes are almost as confusing as the broken images seen through the glass pendants of a chandelier.

In addition to these familiar effects of refraction and reflection, we have the class of phenomena which we call diffraction effects. These may be wave-like fringes of light and shadow following the outline of the transparent object and reduplicating this outline; or they may be analogous fringes thrown off the sub ivided parts of the object, as from the cup-like outline of alveoli, or from some projecting rib or groove like those along the diatom's median line.

We know by constant experience that when we throw light obliquely through a transparent reticulated object like a diatom-shell, the diffraction fringes from the separate alveoli run together across the shell in dark striæ oblique or at right angles to the direction of the light. In the *Pleurosigma*, in which the rows of alveoli are oblique to the midrib, we very easily get the oblique striation by the use of oblique light; getting both series of lines at once, one only, or one strong and the other faint, as we please and with very little trouble. We get, with a little more pains, a transverse striation, at right angles to the midrib, which is fainter because it proceeds from alveoli not so closely connected in rows. It may be called a secondary striation. With still more effort we may get a much finer and fainter striation, parallel to the midrib, by throwing light at right angles to it or nearly so. By lamplight, and with objectives not apochromatic and not exceeding the aperture of 1.0 N. A., these lines are usually in patches, upon spots here and there, longer (in the length of the shell) than they are wide. But with sunlight this tertiary diffraction striation may be made to cover the whole surface of *Pleurosigma angulatum* by an exquisitely fine longitudinal grating over its whole surface, as was demonstrated by Dr. Woodward in one of the most striking of his photomicrographs in what is called "the Abbe experiment."* As the improvement in our lenses, both by increasing

* See R. M. S. Journal, vol. ii. (1879), p. 675; see also M. M. J. xvii., p. 82.

their angle and by the apochromatic system, tends to make visible by lamplight what before could only be seen by sun, we should expect that something like the fibrillæ shown in Mr. Smith's photographs would be visible. Finding it would not prove that it is purely the result of known laws of diffraction ; but it justifies a cautious and scientific scepticism in receiving a new explanation until we have repeated the experiment often enough and under such varying conditions as to exclude doubt.

As we increase or reduce the obliquity of the light in examining *Pleurosigma formosum*, we know that the alveoli are distorted (or may be) in varying ways and directions. Some of these are figured in "Carpenter on the Microscope," but they are only a few of a numerous series. Whoever will experiment a little may satisfy himself that the permutations and transmutations of the diatom markings may be made little short of kaleidoscopic. Hexagonal markings may become square and may have short lines running off from one angle. These lines may be lengthened and the square or hexagon reduced to a dot, so that the appearance of the surface may be that of oblique series of parallel dashes. The direction of these lines depends on the direction of the light, making a series of gratings, of which the prevalent character may be oblique in either of two directions, transverse or longitudinal. The so-called intercostal points may be enlarged and brightened until they become the most prominent marking, and the alveoli proper may be diminished to insignificance. These appearances are so like many of those in Mr. Smith's series that we, who can only see the print and cannot get our fingers upon the fine adjustment of the microscope and note for ourselves the effect of a change of focus, are necessarily made cautious in accepting his interpretations; but there should be caution in rejecting as well as in accepting, and he fairly challenges us to repeat his investigations under similar circumstances and with similar objectives.

An examination of his print No. 12 with a hand lens will illustrate what I am saying. When looked at with the naked eye, this print shows a long patch of longitudinal striation on the lower side of the valve. Immediately below the midrib we see the coarse, oblique dotting peculiar to *Pleurosigma formosum*; but if we use the lens we see at once that, in the patch referred to, the dots are twice as numerous as the alveoli of the shell. The

interpolated ones (proceeding from above downward) are at first very small, then larger but rectangular and twice as long as wide, making the pattern one of alternate dots and rectangles; as we pass to the right the rectangles run into each other obliquely, making a wavy white line, the dots of the alveoli proper being in the bends of the line, very much as in the longitudinal fibrils of print No. 11. This change, distortion, and multiplication of the dots is so entirely within our common experience in diatom-study that I have no hesitation in explaining the longitudinal striated appearance in this patch as the result of the reduplicating of the dots by the intercalation of the rectangular ones, making in fact broken lines which on so small a scale are sufficiently even to make continuous ones to the naked eye. On the other side of the midrib in the same print (No. 12) the rectangles and round dots are of nearly equal size, but they still make a faint longitudinal striation, diverging a little from the midrib as we pass from left to right.

We thus have an ocular demonstration how a striated appearance may be made out of a tessellated one, when there is no question of continuous fibrils. Yet even this does not prove that the fibrils are not there. Of course all visual appearances under the microscope have their cause in the structure of the object, considered in relation to the laws of transmitted and reflected light. The puzzle often is to tell what to attribute to each factor. I do not think it difficult to account for the tesselated appearance of dots and squares with alternate blue and red color. To do so may require us to refer to some elementary matters in diatom-marking.

Dr. Brebisson, at a very early day, divided the regular dotted markings of diatoms into three classes: 1, *Quadrille rectangle droit* (in squares parallel to midrib, e.g., *Pleurosigma balticum*); 2, *Quadrille rectangle oblique* (in squares oblique to midrib, e.g., *P. formosum*); 3, *Quinconce* (quincunx or lozenge of 60° smaller angle, e.g., *P. angulatum*). This classification has been a good deal neglected, but has good claims to remembrance, and will assist me in explaining the phenomena before us.

In Mr. Smith's print No. 6 is well shown what I regard as the normal scheme of areolation of *P. formosum*. It will be seen to be a reticulation with meshes as nearly square as nature gives us

in growing things. If the corners of these meshes be filled up, the included circles will still keep to each other the relative position of Brebisson's oblique quadrille. The diminution of the round alveoli would not need to proceed far before the approximately rectangular mass of silex between the circles would be about as large in diameter as the circles themselves. Under the laws of optics, which we have already seen illustrated in print No. 12, the tendency of approximately rectangular details is to become more strictly so in the microscopical image. In Figure 1 I have illustrated this by a geometric diagram of which one half shows the square reticulation, and the other the resulting tessellation of solid squares and round alveoli when the walls are thickened and the corners filled up. It will be noticed that when the

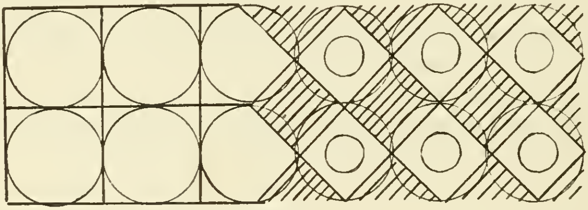

FIG. 1.

corners are so filled as to make the alveoli circular, the interspaces are approximately square, and, being solid, will be red or pink by transmitted light when the alveoli are bluish-white. On the inner side of the shell the thin circles, or 'eye-spots," are usually smaller than on the outer side; the diffraction effect by transmission of light will straighten the edges of the tessellated outline; the squares will each have half the area of, and will be diagonal to, the original squares; and with their alternate colors we shall have exactly the appearance which Mr. Smith describes, and which is very well shown in prints Nos. 1 and 2, compared with No. 6.

The peculiarity of the quincuncial arrangement of alveoli is that when the circles crowd upon each other so as to become polygons bounded by straight lines, they form hexagons instead of squares, and even when they are circles in a continuous plate of silex the hexagonal outline is a persistent ocular illusion. We should expect, therefore, that the tessellated appearance with

equal squares of red and blue would be a mark of *P. formosum* as distinguished from *P. angulatum*, under proper conditions of illumination and examination.

We are justified in concluding, therefore, that the phenomena of color and form thus examined are not only consistent with, but strongly confirm, the generally received theory of diatom-structure, and cannot be said to indicate anything new in that direction.

Mr. Smith also expresses the opinion that only by means of a wide-angled objective, and illumination by a wide cone of light from the sub-stage condenser, can the upper and lower films of a shell like *P. angulatum* be discriminated. As he recognizes some photographs made by me, and deposited with the Royal Microscopical Society in 1884, as showing this discrimination, it is due to scientific accuracy to say that they were made with a Wales $\frac{1}{15}$ water-immersion objective of about 1.0 N. A. aperture, and with a *narrow* cone of light coming from a Webster condenser under the stage having a diaphragm with a $\frac{1}{4}$-inch opening behind it. Mr. Smith's own objects photographed could not be illuminated with a very wide cone of light, as they were mounted dry and he tells us he used his condenser dry. There was therefore a stratum of air both above and below the slide on which the object was mounted, and the illumination could not exceed the "critical angle," 82°, in passing through the cover glass, and must in fact have been considerably less.*

In my own experience I have found a broad cone of illumination unsatisfactory, for the same reason that I have found oblique light in one direction unsatisfactory. It is almost impossible to centre the sub-stage condenser so accurately that a wide cone can be trusted to be central. If you centre it by examination with a low power, it is almost certain that it will not be centred for a high power, for two objectives are rarely centred alike. The field, under a magnification of 1,750 which Mr. Smith has commonly used, is so small that the least decentring will illumi-

* In my note book, June 3d, 1884, I find that I entered my observation of one of the broken shells which I photographed, as follows: "A remarkably interesting fragment of *P. angulatum*, showing partial removal of one film, and fracture through dots over a large space." In preparing this paper I have repeated the examination with the objective named, and find the distance between upper and lower film easily appreciable in focussing.

nate it only by the oblique rays from one side of the cone, and we then immediately get diffraction effects. I am bound in candor to say that in most of Mr. Smith's prints I recognize similar effects to those which, in my own work, I attribute to oblique light. It may be that, with improved contrivances to secure exact centring of objective and condenser, we shall find advantages in the use of the wide cone. I speak now only of my own experience under existing methods. The slightest turn of the mirror on its axis will change light from central to oblique; and I suppose we are all in the habit of doing this, so as purposely to throw light through one side or segment of the condenser for the purpose of studying the effect on an object of the changing direction of illumination. So unstable a source of light prevents our knowing very exactly when the light is strictly central, and makes it hard to return to any exact condition from which we have departed even a little. These considerations have kept me (perhaps mistakenly) in the practice of using the narrow cone of light for photography, reserving my oblique light for special resolutions of striation and for the professed study of changing effects.

Similar reasons have made me distrustful of dry mounts when high powers are to be used upon any but the thinnest objects. Refraction, and attendant diffraction, are so increased with increase of index, or rather increased difference of index, that it has grown to be a maxim with me to have the mounting medium and the object as near alike in index as is consistent with the discrimination of structure. The pale images of transparent objects are those I find most truthful, for paleness is consistent with good definition and resolution, whilst the brilliant pictures are apt to be glittering deceptions. I fully admit, however, that it may well be that with improved glasses we may add to the extent of details visible upon a surface, like that of a diatom-shell, and that it is possible that mounting in most media would obliterate the finest of these details. To a certain extent we are all familiar with this. A rather coarse dry shell like *P. balticum* will have its details instantly obliterated if water from the immersion of our objective penetrates beneath the cover glass Mr. Smith's print No. 50 might pass as an excellent reproduction of this

effect, the fluid passing along the structural lines, obliterating part and leaving part.

But when full weight has been given to all these things, and we have put aside those of Mr. Smith's long and beautiful series of photographs which are liable to our criticism, there still remain several which cannot be thus disposed of.

Prints Nos. 14 and 15, taken with half the magnification of most of the others (× 875), show strips of surface marking which strongly support Mr. Smith's interpretation, viz., that the outer surface of *P. formosum* is covered by a longitudinal series of fibrils separating so as to pass round the alveoli and uniting over the solid corner interspaces. The definition in these cases is not only reasonably clear and free from the ordinary marks of diffraction effects, but, most conclusive of all, there is in No. 15 a bit of this film floated off the shell and lying detached by its side. The fibrillar structure of this bit leaves little room for scepticism, and it so exactly accords with the appearance of the similar fibrils remaining on the surface of the shell that I cannot refuse to accept it as evidence of structure. Going back from these to print Nos. 10 and 11, we now find reason to accept these also as evidences of the same structure, though distorted by obliquity of light, so that they would not have been satisfactory taken by themselves. On No. 5 also we may recognize some of the same fibrils. The single detached fibril in No. 9 is not so directly connected with any other specimen, either in the photograph or in Mr. Smith's description, as to present the evidence on which it is shown to be part of the same structure; but the measurement of its flexures so corresponds with the areolæ of the shell that its probable connection with a similar valve may be assumed.

The interpretation of this structure which seems to me most satisfactory is to regard these fibrils as superposed upon the general surface of the shell as a protection to the thin capping of the alveoli against abrasion. It would, in that case, come under the description of those appearances which I have referred to in paragraph 4 of my general summary (see foot-note, p. 75 ante), viz., a "thickening on the exterior of the lines bounding the areolæ . . . which is not in contravention of, but is in addition to," the usual formation of the shell by means of two principal plates or films. All the species of *Pleurosigma* which have the

alveoli arranged in Brebisson's *quadrille* seem to have strengthened ribs between the rows of "dots"—*P. balticum*, *P. attenuatum*, etc , have them longitudinal and straight. Mr. Smith's observations seem to prove that *P. formosum* and its congeners have them longitudinal but wavy, which is a positive addition to our knowledge, since we should naturally have expected them to be oblique. The appearance of the finer square tessellation in either of the principal films of an obliquely marked *Pleurosigma* would seem to prove it to belong to the "quadrille" marked class, and I think the smaller forms which Mr. Smith has left unnamed may be identified as *P. obscurum* W. Smith, which is probably only a small form of *P. formosum* or *P. decorum*.

I do not find in the prints any conclusive evidence that the quincuncial marked species, as *P. angulatum*, have the same series of fibrils. No one doubts that all have a vegetable membrane in which the silex is deposited, and, under favorable circumstances, a fracture through a row of dots would leave the thicker connecting membrane looking approximately like a fibril. The argument from analogy is not as strong here as in the case of the "quadrille" marked kinds. The structure *may* be found in all, but the evidence does not yet seem complete. There is here a good field for further investigation.

This leads me to say that the size of the fibrils shown by Mr. Smith does not seem to me so minute that any good $\frac{1}{10}$ or $\frac{1}{15}$ objective should not define them. We must remember that the condition of an object may count for much in the resolution of its structure. A thickly silicified shell may not show what an imperfectly silicified one will demonstrate. The former will break into small angular bits with a mineral fracture; the latter may separate into threads or membranes. The floating off of the fibrils in print No. 15 seems to show that the shell was in a peculiar condition; a sort of dissection of an uncommon kind having taken place naturally or artificially. It would be an interesting experiment to subject various species of *Pleurosigma* to the action of hydrofluoric acid for varying periods, and then mount them for examination. To extend Prof. Bailey's old experiments in this direction would be very useful; but the danger of injury to the objective is such that it would hardly be advisable to watch the action of the acid under the microscope.

If I seem to have reduced the new matter in Mr. Smith's observations to a minimum, I should not do justice to my sense of the real value of his work unless I add that enough remains to make it, in my judgment, a very important and interesting step in the investigation of diatom-structure. It is also full of promise that still further results may be attained by pursuing the investigation on the same line. I am confident, therefore, that the Society will join with me in expressing a sincere sense of obligation to him for communicating the results of his observations, and especially for the valuable aid in understanding them which is given by his beautiful series of lantern slides and prints.

THE WORK OF THE MICROSCOPE.

ANNUAL ADDRESS OF THE PRESIDENT, P. H. DUDLEY, C E.

(*Read January 16th*, 1891.)

At no period in the history of the microscope have the results of its researches received as much attention as at the present time. The importance of the investigations in recent years, by its means, of many of the causes affecting the health and comfort of mankind, is just being recognized by the efficacy of the remedies which have been suggested from a knowledge of the causes. The indications of a new remedy are daily flashed from continent to continent by that unseen agency, electricity, its messages multiplied by the press in all languages and distributed through the land by steam's swiftest trains. These three great inventions of communication and diffusion of knowledge of to-day have carried the tidings to the peoples of all nations, and there is a common interest and thought upon the subject. History does not record a grander spectacle than that of the entire civilized world, brought into sympathy and interest by the investigations of the microscope, in search of relief for thousands of its sufferers from some of the occult conditions incident to life.

Animal or plant life, either of the highest or lowest orders, is surrounded by conditions, some favorable to growth, others unfavorable; and whether an animal or plant will survive or perish, aside from the inherent vitality, depends upon the preponderance of the favorable or the unfavorable conditions of environment.

This law is coeval with the existence of life. To ascertain and understand the conditions favorable to the human race has and will always occupy the attention of a large portion of the more intelligent of mankind.

Some of the conditions are at once apparent; others, equally important, are unseen, obscure, and only discovered by tracing back from the effect to the cause. We experience effects and not causes, and to analyze the former, assigning each to its proper cause, is by no means an easy matter. The first step is to observe the facts, study their relations, and trace the laws controlling them. It is only in this way that any progress has been made, and then oftentimes the real nature of the cause remains undiscovered.

Jenner's important discovery of vaccination for small-pox, a century since, was not the result of accident, as often stated, but close observation of a series of facts and studying their relations. That small-pox was due to a germ in the system, invisible to the keenest vision, is of recent demonstration by the microscope.

How early minute forms of life were suspected of causing bodily ailments or decomposition in fluids is uncertain. The Egyptians, 3,500 years since, knew how to practically prevent decomposition in bodies and wooden utensils, so that they have been preserved to the present time. More recently Robert Boyle, 200 years ago, expressed the opinion that ferments had something to do with fevers. Leuwenhoek, 1632 to 1723, made small lenses, and described the ferment of yeast as ovoid or spherical bodies, and discovered bacteria in the mouth and in fluids undergoing decomposition. The powers and use of the early simple microscopes were too limited to definitely establish the functions of the minute forms or their relations to the higher orders The belief, however, was becoming more and more general that the minute forms had something to do with bodily ailments and fermentations, but without microscopical aid it could not be clearly demonstrated. As must be expected, some extravagant views were adopted, while others were close approximations to the truth. Boerhaave, in 1693, distinguished three kinds of fermentations, viz , alcoholic, acetous, and putrefactive. Linnæus stated that a certain number of diseases resulted from animated invisible particles dispersed through the air. Spallanzani, in 1769, started his series of experiments upon spontaneous generation and ste-

rilization, resulting in the present method of preserving foods. Opinions were very conflicting, and the truth, which may now be expressed by a line, required years of labor to ascertain, and really follows the improvement in the microscope. In 1837 Cagniard-Latour described yeast as a collection of globules which multiplied by budding. In 1838 Turpin described the yeast plant in beer, and named it *Torula cerevisiæ*. Many chemists were unwilling to admit the important part played by yeast in fermentations, and ascribed it to "catalysis," or action by presence. In 1843 the celebrated French chemist Dumas, from microscopical and chemical examinations, clearly explained the physiological function of the living ferment, yeast. The truth was now proven, but it made little progress until Louis Pasteur, some ten years later, took up the work of studying under the microscope the ferments of yeast, vinegar, and wine, demonstrating conclusively that a germ must be present to start fermentation or decomposition in fluids, that the definite knowledge he learned of the functions of the minute forms of life attracted attention.

Pasteur, by his systematic work with his microscope, tracing the life history of many ferments from the spore, ascertained the laws of growth, so he could induce fermentation or check it as desired. The ability to keep liquids for years when freed from germs, which under ordinary circumstances would ferment or decompose in a few hours, enabled Pasteur to confirm and clearly set forth the general principles of the germ theory of minute forms of life, in place of the theory of spontaneous generation. The theory so completed, revolutionizing current ideas, met with vigorous opposition, but the microscopical demonstration was so complete it has proven invulnerable, and upon it has been formed the important branch of science, bacteriology. We are too near to estimate the value of the demonstration. It will require time to show its full value, for its application is but really commenced.

Pasteur's work has been pre-eminently practical, and the results of his investigations at once applied to the French industries, in which interests they were undertaken. He saved the French silk industry from threatened destruction by investigating the parasitic diseases of the silkworm, and suggested a remedy. His investigations led to the antiseptic treatment in surgical operations which is now considered indispensable. His extensive

experiments to obtain vaccines, or attenuated virus for protective inoculations, have been very successful, especially when the difficulties of producing an attenuated virus are considered.

The process for obtaining the protective virus for rabies may be mentioned. He inoculates a morsel of the brain of a mad dog into the brain of a rabbit, which attenuates the virus sufficiently to act as a protective inoculation for dogs, or men bitten by dogs, suffering from rabies. At first the attenuated virus from the rabbit was also passed through the organism of the monkey before using. This feature has been discontinued. This was the first successful step towards checking rabies. Pasteur has a large institute in Paris for the treatment of rabies, and there is now in this city a branch institute under the charge of Dr. Paul Gibier, where about 160 persons have been successfully treated the past year.

Considering for a moment the higher orders of plant life, the microscope has shown conclusively that the functions of the fungi which we see upon them is to undo the structure which has been built up by the higher plants, returning the elements composing them to the air and soil. This is of itself a work of great economic value, and must be more generally understood to save our building timber and forests from the natural process of decay.

The rapid advancement of bacteriology in the last decade is largely due to the arduous labors of Koch, who, by extensive microscopical investigations, discovered the specific bacillus of several diseases, particularly of Asiatic cholera and tuberculosis. He originated a method of staining a specific bacillus so as to differentiate it from all others in enclosed tissue or other media, and found them when others not using as skilful methods failed. He originated a system of solid nutritive media for cultivating and isolating a specific bacillus, producing pure cultures. This has proven of the greatest value, for much has been learned as to the manner of growth and products secreted of each bacillus studied. With the pure cultures he carried out extensive inoculations on animals, and carefully noted the effects. The latter have been analyzed, resulting in his extensive experiments with his so-called lymph to check the bacillus of tuberculosis in the human system. It is this feature of Koch's great work which has made his name a household word to-day in all civilized countries.

Yesterday he gave to the world the formula for his great discovery, which, briefly stated, is a glycerin extract of a certain dilution from the ptomaïnes or the products of the bacillus itself.

The consensus of opinion from the tests is that it is a remedy of great value. Besides its direct benefits the indirect ones will be even greater, for the publicity given by the press to this and kindred discoveries is rapidly educating the people to the important rôle played by microbes in contagious diseases, and the necessity of efficient sanitary measures for our cities as a preventive. Check the causes instead of dealing with the dangerous effects, and have clean streets, wholesome water, and efficient sewerage. Any one or all of these, when not in proper condition, are efficient media for the growth of microbes detrimental to health, particularly in cities of warm climates. But few of our cities in warm climates have as wholesome water as is needed for domestic purposes, being so filled with germs as to be unsafe for many persons to drink without sterilization. The indifference of the people to these important matters is largely due to the fact that their nature and bearing are not understood. The reasons why the streets should be clean, the water wholesome, and that there should be efficient sewerage in our cities, are evident to health boards, but it needs enlightened public opinion to more thoroughly carry out the demonstrations of the microscope.

PROCEEDINGS.

Meeting of December 5th, 1890.

In the absence of the President and Vice-President, Mr. William Wales was elected chairman.

Twelve persons present.

The Corresponding Secretary exhibited the first and second numbers of the new publication, *Le Diatomiste,* edited by M. J. Tempère, Paris, and gave notice of the character of the publication.

OBJECTS EXHIBITED.

1. Longitudinal and transverse sections of an Actinia, *Metridium marginatum* Milne-Edwards, showing tentacles, mouth, œsophageal tube, and mesenteric folds : by L. Riederer.

2. Pipe-fish, *Syngnathus acus* L. Entire fish, young, stained: by L. RIEDERER.

3. Sagittal sections of the head of the same: by L. RIEDERER.

4. Type-slide of 50 recent and fossil Foraminifera, prepared by Edmund Wheeler: by H. W. CALEF.

The following all by ANTHONY WOODWARD:

5. Type-slide of 100 species of Foraminifera, from H M. S. "Challenger" Expedition, Torres Straits, 155 fathoms, prepared by Joseph Wright, Belfast, Ireland.

6. Section of *Eozoon Canadense*.

7. Section of fusulina limestone from Nevada. Also many specimens, such as *Planorbulina larvata*, *Calcarina Spengleri*, *Assilina*, *Numulites*, *Orbitoides Mantelli*, *Fusulina cylindrica*, Foraminifera of the U. S. coast, of Bermuda, of Singapore, and of the Vienna Basin, and others embracing forms extending from the carboniferous age to the present time.

A discussion on building-stone was participated in by Messrs. A. Woodward and M. M. Le Brun.

Mr. Riederer gave the following description of his exhibits: "The Actiniæ belong to the Cœlenterata, or zoophytes. They are cylindrical and radially symmetrical. The oral opening is used not only for the reception of the food, but also for the rejection of excreta. This opening is surrounded by tentacles—contractile tubes—bearing, especially near the ends, large numbers of 'nettle-cells'—cnidoblasts.

"The cavity of the body is divided by numerous vertical partitions—mesenteric folds—into a system of vertical pouches, which communicate with one another at the bottom of this gastric cavity. At the upper extremity the pouches are continuous with the canals leading into the hollow tentacles, since the edges of the mesenteries bounding them unite with the wall of the oral tube, which hangs from the mouth. The generative organs rise on the mesenteries as band-shaped or folded thickenings.

"The body of Actinia has no hard structure. By means of contractile muscles, causing inflow and outflow of water, large differences in size and shape are produced. The contractile foot allows departure from the place of attachment. Many Actiniæ reach a relatively large size and possess beautiful colors.

"The Pipe-fish, *Syngnathus acus,* belongs to the Teleostei, or bony fishes. It is the most common and widely propagated fish of its family. The body is cylindrical, laterally compressed, and covered with a mailed skin. The elongated, tubular snout has no teeth, and opens in front at the top. There are four tufts of gills on each side, and the gill-openings are narrow. The males have brood-pouches on the abdomen. The dorsal fin shows forty rays, but the pectoral and anal fins are small. The tail appears like a fan on a long handle at the end of the long body. Thus the propulsion of the fish is done mostly by the undulating movements of the dorsal fin. The Pipe-fish is found between sea-weeds at the bottom of shallow waters, and feeds on small crustaceæ and worms."

Meeting of December 19th, 1890.

The President, Mr. P. H. Dudley, in the chair.

Eighteen persons present.

The following Committee on Annual Reception was appointed by the chair: Messrs. Charles S. Shultz, George E. Ashby, and Anthony Woodward.

OBJECTS EXHIBITED.

1. A Fish-louse: by F. W. Leggett.
2. *Gomphonema herculeanum* from Dutchess County, N. Y.: by J. D. Hyatt.
3. The Polycistin, *Haliomma Humboldtii:* by Stephen Helm.
4. Polycistina from Barbadoes: by James Walker.
5. Foraminifera from Isle of Jersey, England: by James Walker.
6. Section of *Nummulina lævigata* from Bartom, England: by James Walker.
7. Foraminifera from Bermuda: by William G. De Witt.
8. *Orbiculina* from Bermuda: by William G. De Witt.

Mr. Stephen Helm, of 417 Putnam Avenue, Brooklyn, addressed the Society on "The Foraminifera." This address was illustrated by numerous beautiful and enlarged diagrams, especially prepared by Mr. Helm for the occasion.

On motion the thanks of the Society were tendered Mr. Helm for this address.

Dr. H. Hensoldt remarked upon the subject of the Foraminifera, reviewing the interesting geological side of the subject.

Mr. Hyatt said of his exhibit that it was collected on the 23d of November last, from a brook in Dutchess County, N. Y., where it suddenly appeared, and increased so rapidly as to cover the stones, etc., on the bed of the stream to the thickness of more than one-quarter of an inch. And, further, that the only published locality for this rare diatom is Lake Erie.

Meeting of January 2d, 1891.

The President, Mr. P. H. Dudley, in the chair.

Thirty-five persons present.

The Committee on Nominations of Officers, appointed at the meeting of November 21st, 1890, reported their nominations of the persons who were unanimously elected, as is stated below.

The President appointed as tellers of the election of officers the Rev. George C. F. Haas and Mr. Horace W. Calef.

Mr. Charles F. Cox read the following papers, as announced on the programme of the evening:

1. "On the Structure of the Pleurosigma Valve"; by T. F. Smith, Esq., F.R.M.S., of London, England. This paper, published in the present number of the Journal, p. 61, was illustrated by lantern projections of fifty excellent lantern slides, from original photomicrographs, and by numerous other mounted photomicrographs, by Mr. Smith.

2. "Diatom-Structure—The Interpretation of Microscopical Images"; by Jacob D. Cox, LL.D., F.R.M.S., of Cincinnati, Ohio

This second paper, published in the present number of the Journal, p. 73, was illustrated by one hundred photomicrographs, twelve of which were by the late Col. J. G. Woodward.

Mr. Charles F. Cox announced the donation to the Society by Mr. T. F. Smith of the fifty lantern slides just exhibited.

On motion it was resolved that the thanks of the Society be hereby tendered Mr. T. F. Smith for his interesting and valuable paper, "On the Structure of the Pleurosigma Valve," and for his

valuable donation of fifty photomicrographic lantern slides illustrating the same.

On motion it was also resolved that the thanks of the Society be hereby tendered Gen. Jacob D. Cox for his admirable paper on "Diatom-Structure—The Interpretation of Microscopical Images."

The President announced the closing of the polls, and declared the result of balloting to be the election of the following persons as officers of the Society for the present year:

President, P. H. DUDLEY.
Vice-President, J. D. HYATT.
Recording Secretary, BASHFORD DEAN.
Corresponding Secretary, J. L. ZABRISKIE.
Treasurer, CHARLES S. SHULTZ.
Librarian, LUDWIG RIEDERER.
Curator, WILLIAM BEUTENMÜLLER.
Auditors, { WILLIAM E. DAMON, F. W. LEGGETT, H. W. CALEF.

MEETING OF JANUARY 16TH, 1891.

The President, Mr. P. H. Dudley, in the chair.

Twenty-five persons present.

The Treasurer, Mr. Charles S. Shultz, presented his annual report, which was accepted and adopted, and the summary of which is as follows:

Receipts, - - - - -	$530 08
Disbursements, - - - -	421 47
Balance, - - - -	$108 61

The Committee on Publications presented their annual report, which was accepted and adopted.

The Curator, Mr. William Beutenmüller, presented his annual report, stating that he was now cataloguing the slides in the cabinet of the Society, and also that the six revolving tables now in the Society's Rooms had been lately there deposited by some unknown parties.

On motion the thanks of the Society were tendered the donors of these elegant and useful tables.

The President made the following appointments:

Committee on Admissions: F. W. Devoe, Anthony Woodward, William E. Damon, George F. Kunz, and William Wales.

Committee on Publications: J. L. Zabriskie, William G. De Witt, Walter H. Mead, John L. Wall, and Charles F. Cox.

The President delivered his annual address, entitled "The Work of the Microscope," and published in this number of the JOURNAL, p. 87.

Mr. Stephen Helm, of 417 Putnam Avenue, Brooklyn, delivered the third of his series of addresses, entitled "The Rotifera." This address was illustrated by beautiful enlarged diagrams, and by living objects under microscopes.

OBJECTS EXHIBITED.

1. *Stephanoceros Eichhornii:* by STEPHEN HELM.

2. *Floscularia ornata:* by STEPHEN HELM.

3. Longitudinal section of head of embryo of Garter Snake, *Eutania sirtalis* L.: by L RIEDERER.

4. Transverse section through nose of the same: by L. RIEDERER.

5. Transverse section through eye of the same: by L. RIEDERER.

In discussion of the address, Mr. C. Van Brunt stated, as the result of his observations on the desiccation of Rotifera, that when they are dried on the surface of clean glass they are dead and incapable of resuscitation; but if dried among fragments of dirt or vegetable matter they may be revived. He had some pond mud, which had been kept dry, wrapped in paper, for the space of five years. When portions of this were moistened with water the contained Rotifera would revive in two hours' time.

Mr. Riederer remarked on his exhibits: "This harmless snake, *Eutania sirtalis*, belongs to the family Colubridæ. It has a moderately broad and distinct head, covered with scutes. The dentition is complete. It shows a remarkable variability, which has given opportunity to the formation of quite a number of sub-species.

"In the following remarks I refer only to such points as can be seen in the transverse or the sagittal sections of the head of the embryo here exhibited. Commencing with the lower jaw,

we see the cartilaginous structure of the bones, as yet unossified, bundles of muscles, and blood vessels. The forked, horny tongue is enclosed in a sheath, from which it can be protruded through an indentation of the mouth, even when the mouth is closed. Above the tongue is the larynx. This is placed extraordinarily far forward, and can be projected into the mouth during the long and difficult act of swallowing. The adjoining trachea shows cartilaginous rings. While all reptiles breathe only by lungs, the embryonic stage of the object still shows the presence of gills. The gullet has a thin, extensible wall. The nasal apertures are placed near the apex of the snout. The olfactory organ has a second groove, with a large surface of mucous membrane, supported by cartilaginous whorls. The olfactory nerve rises at the end of the olfactory lobe, and is spread out like a cup around a cartilaginous papilla. The eyes are without lids, but are protected by a transparent capsule, formed by the skin, filled with lachrymal fluid, and transparent in front of the pupil and cornea. The eyes show all the constituents of a highly developed vertebrate: cornea, crystalline lens, anterior and posterior chamber, iris with pupil, retina with its different layers, choroid with pigment, and optic nerve. The brain, enclosed in the cartilaginous capsula, shows differentiation in layers and structure."

PUBLICATIONS RECEIVED.

The Microscope: Vol. X., No. 11--Vol. XI., No. 1 (November, 1890—January, 1891).

Bulletin of the Torrey Botanical Club: Vol. XVII., No. 12—Vol. XVIII., No. 2 (December, 1890—February, 1891).

Natural Science Association of Staten Island: Proceedings; Meetings of December, 1890, and January, 1891.

Journal of Mycology: Vol. VI., No. 3 (January, 1891).

The Botanical Gazette: Vol. XV., No. 12—Vol. XVI., No. 2 (December, 1890—February, 1891).

Insect Life: Vol. III., Nos. 4, 5 (November, 1890, January, 1891).

Entomologica Americana: Vol. VII., No. 12 (December, 1890).

Psyche: Nos. 175—178 (November, 1890—February, 1891).

Anthony's Photographic Bulletin: Vol. XXI., No. 23—Vol. XXII., No. 3 (December 13, 1890—February 14, 1891).

Academy of Natural Sciences of Philadelphia: Proceedings; 1890, Part 2.

Connecticut Academy of Arts and Sciences: Transactions; Vol. VIII., Part 1 (1890).

New York Academy of Sciences: Transactions; Vol. X., No. 1 (October, 1890).

School of Mines Quarterly: Vol. XII., No. 1 (November, 1890).

American Museum of Natural History: Bulletin; Vol. III., No. 1 (December, 1890).

Rochester Academy of Science: Proceedings; Vol. I., No. 1.

Cincinnati Society of Natural History: Journal; Vol. XIII., No. 4 (January, 1891).

Newport Natural History Society: Proceedings; Part 7 (1890).

California Academy of Sciences: Occasional Papers; Parts 1, 2 (1890).

Saint Louis Academy of Science: Constitution and List of Members (1890).

Colorado Scientific Society: Proceedings; Vol. III., Part 2 (1889).

Meriden Scientific Association: Transactions; Vol. IV. (1890).

Bulletin of the Essex Institute: Vol. XXII., Nos. 4—6 (April—June, 1890).

West American Scientist: Vol. VII., No. 55 (December, 1890).

Vassar Brothers Institute: Transactions; Vol. V., Nos. 1, 2 (1890).

United States Geological Survey: Ninth Annual Report (1888).

Cornell University College of Agriculture: Bulletins Nos. 23—25; Annual Report (1890).

Kansas State Agricultural College: Bulletin No. 12 (August, 1890).

Agricultural Experiment Station of Alabama: Bulletin No. 20 (November, 1890).

Michigan Agricultural Experiment Station: Bulletins Nos. 67—69 (October, November, 1890).

United States Department of Agriculture: Farmer's Bulletin No. 2 1890).

Boston Society of Natural History: Insecta; By Alpheus Hyatt and J. M. Arms.

Le Diatomiste: Vol. I., No. 3 (December, 1890).

Johns Hopkins University Circulars: Vol. X., Nos. 84, 85 (December, 1890, February, 1891).

Electrical Engineer: Vol. X., No. 133—Vol. XI., No. 146 (November 19, 1890—February 18, 1891).

Mining and Scientific Review: Vol. XXV., No. 22—Vol. XXVI., No. 8 (November 27, 1890—February 19, 1891).

The Brooklyn Medical Journal: Vol. IV., No. 12—Vol. V., No. 2 (December, 1890—February, 1891).

The Satellite: Vol. IV., Nos. 4, 5 (December, 1890, January, 1891).

The Hahnemannian Monthly: Vol. XXV., No. 12—Vol. XXVI., No. 2 (December, 1890—February, 1891).

Indiana Medical Journal: Vol. IX., Nos. 6, 7 (December, 1890, January, 1891).

American Lancet: Vol. XIV., No. 12—Vol. XV., No. 2 (December, 1890—February, 1891).

National Druggist: Vol. XVII., No. 11—Vol. XVIII., No. 4 (December 1, 1890—February 15, 1891).

Journal of the Royal Microscopical Society: 1890. Part 6.

Journal of the Quekett Microscopical Club: Vol. IV., No. 28 (January, 1891).

International Journal of Microscopy and Natural Science: Vol. IV., Nos. 1, 2 (January, February, 1891).

The Naturalist: Nos. 185—187 (December, 1890—February, 1891).

Grevillea: No. 90 (December, 1890).

The Ottawa Naturalist: Vol. IV., Nos. 9, 11 (December, 1890, February, 1891).

The Canadian Institute: Transactions; Vol. I., No. 1 (October, 1890).

The Canadian Record of Science: Vol. IV., No. 4 (October, 1890).

Natural History Society of New Brunswick: Bulletin No. 9 (1890).

The Victorian Naturalist: Vol. VII., Nos. 6—9 (October, 1890—January, 1891).

Bulletin de la Société Belge de Microscopie: Vol. XVII., Nos. 1—3 (1891).

Société Royale de Botanique de Belgique: Comptes-rendus; Vol. XXX., Part 2 (1891).

Wissenschaftlicher Club in Wien: Monatsblätter, Vol. XII., Nos. 2—4 (November, 1890—January, 1891); Ausserordentliche Beilage, Vol. XII., Nos. 3, 4 (November, December, 1890).

Nuovo Giornale Botanico: Vol. XXIII., No. 1 (January, 1891).

Bollettino della Società Africana d'Italia: Vol. X., Nos. 9—12 (September—December, 1890).

Revue de Bibliographie Médicale, Beyrouth: Vol. II., No. 3 (September, 1890).

Memorias de la Sociedad Científica "Antonio Alzate": Vol. III., Nos. 11, 12 (May, June, 1890).

Notarisia Commentarium Phycologicum: Vol. V., No. 21 (October, 1890).

La Nuova Notarisia (January, 1891).

Naturwissenschaftlicher Verein, Frankfurt (Oder): Monatliche Mittheilungen, Vol. VIII., Nos. 4—7 (July—October, 1890); Societatum Litteræ, Vol. IV., Nos. 7—9 (July—September, 1890).

Königl. Böhm. Gesellschaft der Wissenschaften, Prag: Sitzungsberichte (1889—1890); Jahresbericht (1889); Abhandlungen, Vol. III., No. 3 (1889—1890.)

Jahrbücher des Nassauischen Vereins, Wiesbaden (1890).

PESTALOZZIA INSIDENS.

JOURNAL

OF THE

NEW-YORK MICROSCOPICAL SOCIETY.

VOL. VII. JULY, 1891. No. 3.

THE FUNGUS, PESTALOZZIA INSIDENS.

BY J. L. ZABRISKIE.

(*Read March 6th*, 1891.)

This fungus I collected at New Baltimore, near Albany, N. Y., in 1872. I presented specimens to our State Botanist, Prof. Charles H. Peck, and he reported it in his Twenty-eighth Report, but the description has never been published. I take the opportunity to give that description now.

PESTALOZZIA INSIDENS, n. sp. On bark of living trunks of *Ulmus Americana* L. New Baltimore, N. Y., April, 1872. Acervuli scattered, erumpent, discoid, 300–500 μ in diameter ; conidia 32 μ long exclusive of the bristles, and 12 μ in diameter, broadly elliptical, slightly curved, 5-septate, the four inner cells very dark brown and slightly constricted at the septa, terminal cells hyaline, the upper terminal cell nearly hemispherical, the lower terminal cell conical and distinctly truncated at the union with the basidium, each terminal cell obliquely prolonged in a stout, curved, sometimes flexuous, gradually tapering, abruptly terminated bristle ; bristles 17 μ long ; basidia slender, sometimes branching below, and sometimes 214 μ long.

Description of Plate 28.

The figures are all magnified 600 diameters. The central figure shows a mature spore attached to its basidium, the latter being frequently found of this length. Near the base of the basidium is seen a portion of a broken branch. The basidia are occasionally found thrice branched. On the left is shown a mature detached spore, and on the right an immature spore.

The genus is named after the celebrated botanist, Pestalozzi. I have given it the specific name *insidens*, on account of the somewhat grotesque appearance of the spore when attached to its basidium, resembling an animal perching or sitting on the tip of a pole.

Many species of this genus are described. They usually are parasitic on leaves, and usually have several attenuated bristles spreading from the tip of the upper hyaline cell. Several species have a single bristle in the same position, but I know of only one other which has a single bristle rising from the tip of each hyaline cell.

The other species exhibited, *P. tremelloides*, E. & E., I discovered upon bark of uncultivated grape at Skaneateles Lake, N. Y., in July, 1872. It has been described by Ellis and Everhardt. The compound spore is as long as that of *P. insidens*, but not so robust. It has a crest of from three to six spreading, attenuated, sometimes branched bristles rising from the tip of the upper hyaline cell. In fine, this is a typical *Pestalozzia*, unusually developed in the size and elegance of its compound spore, in the number and branching of its bristles, and in the tremulous character of its spore masses when the latter are moist.

THE DISCOVERY OF MICROSCOPIC TOURMALINES IN THE MICAS OF MAINE.

BY EDWIN S. DRAKE.

(*Read February 6th*, 1891.)

Gentlemen of the New-York Microscopical Society:—By the kindness of my friend, Dr. Bolles, I am enabled to lay before you a brief account of a discovery, which I was so fortunate as to make in the autumn of 1889, of microscopic crystals of Tourmaline. You may know that the State of Maine has long had a reputation for its fine Tourmalines. Having many times found, when visiting one of the localities, pieces of mica with visible needles of this mineral enclosed, I, in the autumn of 1889, procured a piece of the mica for the purpose of seeing the high polarizing quality of the Tourmaline, of which I had read but had never seen. The crystals which this piece of mica contained were

green, tapering from the one-fiftieth of an inch to one one hundredth in a length of one and one-half inches. (These are approximate dimensions and are given from memory.) One day, looking at the mica in a strong sunlight, I observed what I thought were minute crystals, and, putting them under the glass, they were clearly defined. This prompted me to examine other pieces of mica, and resulted in the discovery of the crystals which are now submitted for your examination. I have gone on in my discoveries from small to smaller, and still smaller crystals or groups of crystals ; from finding them as radiations from visible nuclei, to finding them entirely isolated.

A word in regard to the mica in which they occur. You are doubtless aware that all the fine Tourmalines which have been found in our mines are found detached, in pockets in the rock, and not enclosed in a gangue or matrix. While in all these localities mica, containing radiating crystals of Tourmaline, is found in what we have come to call the *mineral sheet*. I have never found a piece of mica containing microscopic crystals except immediately in connection with a pocket. In my search for such mica I have handled over hundreds of pounds of mica taken from the mineral sheet, without finding anything, and in all my searches I do not think I ever found ten pounds that paid for the trouble of taking it apart layer by layer. In fact, all the specimens I have came from that one of our Tourmaline localities known as Mount Apatite, in Auburn, Maine.

The crystals occur very much as dendrites do between the laminæ of the mica, but one specimen amongst those sent, numbered 1, will show a peculiarity of their occurrence worth remark. To illustrate by supposition, suppose the Tourmaline crystal was first formed, in the shape of an open hand laid flat, with the fingers apart, the hand resting upon a continuous sheet of mica. The next sheet above would be continuous around the hand, but would send tongues up between the fingers, and so on, until the fingers had been enclosed, when a cap-sheet covering the whole would be formed. Slide No. 1 shows this crypt in which the crystal (slide No. 2) was enclosed.

I said in a letter to Dr. Bolles that the whole thing seemed to me to be "one big interrogation mark." This is conundrum No. 1. Were the Tourmaline crystals formed before or after the crys-

tallization of the mica? With nothing to contradict this, we might assume that the Tourmaline was formed first. I had no sooner commenced to believe this, than I found crystals crossing a fault in the mass of mica (probably caused by compression during some of the earth throes which the rocks had endured), which, upon one side, were *above* the continuous sheet, and, upon the other side, *below* the same sheet. One piece of mica, which was, I think, the richest in crystals which I have had, was nearly valueless from the difficulty of getting a crystal out because of this trouble. No matter what care I took, I shattered them.

Some idea of the variety of forms found can be got from the slides Dr. Bolles will show you. I have never seen two that could be said to resemble each other except in a general way. You might say of one group that they were fan-shaped, of another that they were palm-like, of another that they were plumose. The variety is infinite. I have mounted nearly one hundred slides, and I have examined under the glass probably three hundred, but the variety is so great that I have felt unable to attempt a classification by form. I hope you may appreciate my difficulty. I know you would if I could have the pleasure of showing you the collection.

I should like to remark upon another of my questions. By what I have learned of the laws of crystallization, I have been taught to expect that the association of given elements, in given proportions, will give a crystal having certain invariable features, constant in its angles, manner of modification by twinning, etc. The typical crystal of Tourmaline is a three-sided prism, having a three-sided pyramidal termination, striated longitudinally, never tapering in a detached crystal within my observation. I have never but once seen a detached crystal curved. But the slides show tapers, curves, etc., till they are bewildering. In the largest of the enclosed crystals I have been unable to discover longitudinal striation, and the form of the crystals has changed to a flat, blade-like form, in some cases represented by a blade of grass. Also, in most of my specimens the crystals are curved; the straight are the exceptions. In the slide marked No. 3 is an exceptional appearance, which I can only account for upon the theory of alteration. You may agree with me by observing that the crystal polarizes only in the thicker parts.

One thing I have omitted to mention which is of interest. Microscopic crystals are seldom found in clear, straight, laminated mica. They are much more likely to occur in mica which I should describe as crinkled. The piece of mica enclosed in the paper, marked "A," will explain my meaning. I think there are seven separate and distinct crystals in this piece. At one place three fan-shaped crystals can be brought within the field of my one-inch objective, although when the three are seen they will all be well toward the outer limit of the field.

A brief description of my method of getting my specimens ready to mount may be of interest. Having discovered a crystal by examining the piece of mica in a strong light, and by the aid of a hand-glass of two to three inches focus, I endeavor to remove the mica, layer by layer, until I have lifted off the last continuous covering layer, then to do nearly the same thing from the other side until I have removed all but the last layer. This can be done quite easily by cutting out, with the scissors, a square with the crystal about in the centre. Mounting upon a slide is quite simple when the specimen is thus made ready. I have had better success with Canada balsam than with glycerin jelly, but there may be better media with which I am not acquainted. My methods are the methods of twenty-five years ago, as I have hardly looked through a microscope till I found the microscopic Tourmalines, and, being a busy man, I have had no time to give to it, excepting in the evening, generally after nine o'clock.

Hoping I may have been enabled to bring to your notice something before unknown, and which may give you pleasure, and asking your kind indulgence for my slides, which I am aware are faulty in preparation,

I am, very truly,

Your obedient servant,

EDWIN S. DRAKE.

PORTLAND, Maine, January 13th, 1891.

PROCEEDINGS.

Meeting of February 6th, 1891.

The President, Mr. P. H. Dudley, in the chair.

Fourteen persons present.

Mr. Anthony Woodward announced the death at Bournemouth, England, on January 10th, 1891, of Mr. Henry Bowman Brady, F.R.S., LL.D., the writer on Foraminifera in connection with the "Challenger" Expedition.

Rev. E. C. Bolles, D.D., presented a paper by Mr. E. S. Drake, of Portland, Maine, entitled "The Discovery of Microscopic Tourmalines in the Micas of Maine." This paper was illustrated by twenty microscopical slides prepared by Mr. Drake, and it is published in this number of the Journal, page 102.

In the discussion of this paper Dr. Bolles said that this mica is found in pieces of about the size of the human hand. A beautiful, plate-like form of quartz is sometimes found in mica, but not in the locality here mentioned. And, further, that Mr. Drake deserves great credit for isolating these crystals, which are exceedingly fragile.

Mr. J. D. Hyatt said that he had found crystals which resembled these in the mica of Manhattan Island, New York.

OBJECTS EXHIBITED.

1. Twenty microscopical slides, prepared by Mr. E. S. Drake, illustrating the paper of the evening: by E. C. Bolles.

2. Balancer of the House-fly, *Musca domestica* L., with so called auditory organs: by J. L. Zabriskie.

Mr. Zabriskie said that the balancers of the diptera are doubtless rudimentary posterior wings. They are of dumb-bell form, situated upon, and directed outward and backward from the posterior sides of the thorax. The hou e-fly has two curious structures on the opposed surfaces of the enlarged base of each balancer, which structures are considered by some authors to be auditory organs. These structures occupy elliptical enclosures, which are crossed transversely by ten or eleven prominent ridges of beads, the ridges being separated by flattened depressions, and the depressions being furnished at regular intervals with stout hairs curving backward over the ridges.

Mr. George F. Kunz donated to the Library of the Society Special Report No. 8 of the U. S. Department of Agriculture, entitled "Cotton in the Empire of Brazil (1885): by John C. Branner, Ph. D."

Meeting of February 20th, 1891.

The President, Mr. P. H. Dudley, in the chair.

Twenty-seven persons present.

Mr. H. W. Calef was elected Recording Secretary *pro tem.*

The Corresponding Secretary presented a communication from the New York Academy of Sciences requesting the appointment of "two commissioners to meet with the same number from each of the other scientific societies located in New York City, with a view to holding a conference at which can be discussed plans for mutual benefit."

The Chair appointed as such commissioners Rev. J. L. Zabriskie and Mr. J. D. Hyatt.

Dr. Charles E. Pellew addressed the Society on "The Bacillus of Tuberculosis"

In a most able and interesting manner Dr. Pellew explained the character and operation of tuberculosis, the nature, operation, and culture of various bacilli, and gave a biographical sketch of Dr. Koch, with especial reference to his experimentation connected with the discovery of the properties of "the lymph," and the method of the employment of the latter in combating the disease.

The address was illustrated by an admirable projection of numerous lantern slides, by large colored diagrams, growth of bacilli in culture tubes, a large preparation on glass of human tuberculous mesentery, a bottle of the "Koch lymph" just received from Germany, and the following objects under microscopes, exhibited under the supervision of Dr. Pellew's assistants, Messrs. H. S. Stokes, H. C. A. Amory, and A. S. Vosburgh:

OBJECTS EXHIBITED.

1. Tubercle bacilli in sputum.
2. Giant cell in tubercle of finger.
3. *Bacillus megaterium.*

4. Comma bacilli of *Cholera Asiatica.*
5. Spirilli of *Cholera nostras.*
6. Pneumonia micrococcus.
7. Anthrax bacillus.
8. Anthrax bacillus in blood of mouse.

MEETING OF MARCH 6TH, 1891.

The President, Mr. P. H. Dudley, in the chair.

Eighteen persons present.

Mr. T. F. Smith, F.R.M.S., of London, England, was elected a Corresponding Member of the Society.

OBJECTS EXHIBITED.

1. Shell of Common Shrimp, *Crangon vulgaris* Fab., showing pigment cells in under layer: by L. RIEDERER.

2 Pollen in honey of the Hive-bee, *Apis mellifica* L.: by L. RIEDERER.

3. The fungus, *Pestalozzia insidens*, n. sp., on *Ulmus Americana* L.: by J. L. ZABRISKIE.

4. The fungus, *Pestalozzia tremelloides*, E. & E., on *Vitis* sp., by J. L. ZABRISKIE.

5. Ash block from Colon, S. A., containing living specimens of *Calotermes flavicollis* F., sent by Mr. J. Beaumont: by P. H. DUDLEY.

6. A ruling on glass by the late Charles Fasoldt, with bands from 5,000 per inch to those said to be 200,000 per inch: by P. H. DUDLEY.

7 Ore from Chihuahua, Mexico, containing iron, silver, copper, lead, and zinc: by H. W. CALEF.

Mr. Anthony Woodward, chairman of the Committee on Annual Reception, reported progress, explaining the extended work of the Committee in their endeavor to make provision for a creditable reception.

Mr. Riederer explained his exhibits as follows:

1. Shell of the Common Shrimp, *Crangon vulgaris* Fab. Some crustaceans, like some amphibians, fishes, and cephalopods, have cromatophores, or pigment-cells. I have found only brief notes concerning such pigment-cells in crustaceans, and therefore make this statement respecting amphibians and cephalopods.

Claus remarks on pigment-cells in cephalopods, as *Sepia* and *Loligo* : "The walls of the pigment-cells are formed of a cellular membrane, to which numerous radiating muscular fibres are attached. When these contract the cells are pulled into a star-shape, and the pigment is distributed. When contraction ceases the cell returns, by the elasticity of the wall, to its original spherical shape, and the pigment is concentrated into a small space, thus the animal changes color. As far as color is concerned, there are usually two kinds of chromatophores, placed near and one above the other. They are connected with a special centre on the stalk of the optic ganglion, and they cause a rapid interchange of blue, red, yellow, and dark color."

In amphibians the various colorings of the skin are principally due to branched pigment-cells of the cutis. The change of color in frogs is caused by changes in the form of these cells.

2. Pollen in honey of the Hive-bee. When bees gather nectar from the flowers, they also gather ripe pollen, which is brushed off by the hairs which cover the body. Bees, like flies, frequently clean their bodies. This act of cleansing is chiefly accomplished by the fore legs, on which they have a comb-like attachment—exhibited before this Society on several occasions. And the collected pollen, often carried home in large loads, they fasten on the broadened part of the hind legs, the "pollen baskets." *

Even honey taken from the hive invariably contains more or less of pollen ; and the scum, forming on honey after standing for some time, consists almost exclusively of pollen grains and a few other impurities, such as hairs of bees and butterflies. The presence of these impurities is a good test of the quality of honey. Large quantities of glucose, made from maize, are sold under the name of honey. Such honey, as might be expected, contains no pollen.

Mr. Zabriskie explained his exhibits as stated on page 101.

Mr. Dudley explained his exhibits of Termites in blocks of White Ash prepared by Mr. Beaumont. Each block has a shal-

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* The Hive-bee certainly uses also the mandibles and the legs in collecting pollen, especially when the latter is abundant in the particular flowers which it is at the time frequenting. And in such times of abundance the loads in the corbiculæ, or "pollen baskets," may be seen to be increased by a rapid and very peculiar combined motion of all the legs, passing backward the pollen mixed with adhesive nectar, while the bee rises from and is still hovering over the flower.—Ed.

low cavity hollowed in the upper surface, large enough to freely contain the living Termites, which are held captive by a glass slip fastened over the cavity. The block under the microscope is tenanted by two auxiliary queens, one soldier, and three workers of the species mentioned.

Mr. Dudley also stated that he had seen the rulings of the late Mr. Fasoldt, exhibited under the preparer's own manipulations of illumination and magnification, and that he was able to distinguish the bands said to be 190,000 to the inch.

Meeting of March 20th, 1891.

The President, Mr. P. H. Dudley, in the chair.

Eighteen persons present.

Mr. J. D Hyatt, of the Commissioners appointed by the Society to the Conference of the Scientific Societies of New York City, reported the action of said conference. The report was accepted and adopted, and on motion it was resolved: That the present Commissioners be continued in their office for the ensuing year.

Mr. Anthony Woodward, chairman of the Committee on Annual Reception, reported the action of his Committee in arranging for a reception to be held at the American Museum of Natural History in Central Park, on the evening of April 17th next, and stated that the use of the first floor and lecture room of the Museum was offered gratuitously by the authorities to the Society for such purpose.

On motion it was resolved: That the Corresponding Secretary be directed to convey to President Morris K. Jesup and the Trustees of the Museum the hearty thanks of the Society for this kind offer.

Dr. Edward G. Love exhibited one hundred projections of lantern slides of his photomicrographs, and Mr. Charles F. Cox also exhibited projections of a large series of lantern slides made from Dr. Woodward's celebrated prints of diatoms.

[We heartily recommend the new work, "Appleton's School Physics," published by the American Book Company. One desiring assistance in comprehending the foundation principles and

operations of optical instruments will find clear, accurate, and valuable instruction in the chapter on "Light," comprising seventy-eight pages, treating of reflection, refraction, lenses, the spectroscope, photography, vision, polarization, etc., abundantly and beautifully illustrated.—Ed.]

PUBLICATIONS RECEIVED.

The American Monthly Microscopical Journal: Vol. XI., No. 12—Vol. XII., No. 5 (December, 1890—May, 1891).

The Microscope: Vol. XI., Nos. 2—4 (February—April, 1891).

Microscopical Bulletin and Science News: Vol. VIII., No. 1 (February, 1891).

Bulletin of the Torrey Botanical Club: Vol. VIII., Nos. 3—6 (March—June, 1891).

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Natural Science Association of Staten Island: Proceedings; February 14—May 9, 1891).

Psyche: Vol. VI., Nos. 179—182 (March—June, 1891).

Insect Life: Vol. III., Nos. 6—8 (March, April, 1891).

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Hahnemannian Monthly: Vol. XXVI., Nos. 3—6 (March—June, 1891).

The Satellite: Vol. IV., Nos. 6—9 (February—May, 1891).

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Royal Society of New South Wales: Journal; Vol. XXIV., Part 1 (1890).

Victorian Naturalist: Vol. VII., Nos. 10—12 (February—April, 1891).

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Ottawa Naturalist: Vol. IV., No. 12—Vol. V., No. 3 (March—June, 1891).

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Société Imperiale des Naturalistes de Moscou: Bulletin, 1890, Nos. 2, 3.

Académie d'Hippone: Comptes-Rendus, No. 8 (1890).

Corrections to be made in the number of the JOURNAL for April, 1891:

Fig. 12, plate No. 27 should be reversed in order to agree with General Cox's references to it on page 80.

Page 81, eleventh line from bottom, for Dr. Brebisson read De Brebison.

Page 85, fourteenth line from top, for No. 15 read No. 14.

Page 86, ninth line from bottom, for No. 15 read No. 14.

JOURNAL

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STRUCTURE IN STEEL.

BY P. H. DUDLEY.

(*Read June 19th*, 1891.)

The subject is so vast and important that I shall confine my remarks principally to rail steel. Besides the iron forming the basis of ordinary steel rails, they have a large range in chemical composition, as shown by the following table:

	Parts of 1 per cent.
Carbon	.25 to .50
Manganese	.30 to 1.50
Silicon	.04 to .30
Phosphorus	.03 to .15
Sulphur	.04 to .10
Copper	.10 to .80

Traces of other minerals are present.

This alloy, being formed by fusion and cast, is of course crystalline in structure. The texture will be fine or coarse, according to composition, size of ingot, rapidity of solidification, amount of mechanical work given to the metal in reducing to the section of the rail, shape and size of the latter, and the temperature at which the rail is finished. In a section of rail of which the ingot or bloom was maintained at too high temperature, the crystallization becomes coarse and often sharply defined, the matrix enclosing or joining the crystals weak and breaks upon the surface, instead of pulling out the portions which penetrated the large pseudo-crystals. The delicate matrix enclosing the pseudo-crystals is shown in specimen No. 1 with low powers, but few

traces of lines from the matrix are seen to penetrate to the interior of the polygons. This specimen is from the tire of a steel wheel, is very hard, and contains 6 per cent of manganese. Wheels of such steel have given a very large mileage. Specimen No. 2 is from a rejected heat of rails, and contains .90 of carbon. The ingot was maintained at too high a heat in the reheating furnace, coarse crystals resulting in the head of the rail, and, as will be seen, they are quite well defined. In the fracture the crystals have separated from each other through the matrix without breaking the individual crystals. This shows first the overheating of the steel, which, in a large head of a rail, does not receive sufficient work to break up this coarse crystallization. The distance across the axis of the crystals measures $\frac{150}{1000}$ to $\frac{175}{1000}$ of an inch, which, for a good wearing rail, I consider coarse, though the majority of rails in the track are much coarser. Specimen No. 3 is from the same rail, taken near the top of the head, and shows that the mechanical treatment of rolling has broken up the coarse crystallization, rendering it practically amorphous, very fine in texture—in fact, much finer than can be expected in rails until higher carbons are reached than has been until recently considered advisable to put in the tracks. As we increase the carbon in rails we increase the hardness, raise the elastic limit and tensile strength, but, on the other hand, decrease the elongation, and, without great care, render the steel brittle under shock instead of retaining sufficient toughness in the rails to render them safe in the track during winter in this latitude. The element phosphorus tends to render rails brittle, or cold-short, and as the carbon is increased the phosphorus must be decreased, at least with ordinary sections having deep heads and thin bases. Phosphorus exists in the pig iron, or the ores from which the pig iron is made, and to such an extent in many ores that they are unsuitable for Bessemer metal, and it requires some care to select ores which will run from .08 to .10 of 1 per cent of phosphorus, about the limit to be combined with .35 to .40 of 1 per cent of carbon. While rails, many years since, containing .35 to .40 in carbon were suitable for the traffic at that time, they wear too rapidly under the present traffic. To increase the carbon for better wearing qualities, it is first necessary to introduce a section for heavy rails which would cool more uniformly, reducing the coarseness

of the texture, and at the same time keep the phosphorus down to avoid brittleness.

In 1883 I designed an 80-pound section, which makes the structure of the metal in the head much finer than usual. The section was put into service in 1884, the manufacture of which became the type of modern sections. Over 200,000 tons of this section have been put into service, some of the rails having .50 in carbon. Even with so much carbon the elastic limits of the steel are below what is necessary for modern traffic, and I am now making rails with .60 carbon, the phosphorus being down to or under .06. Specimen No. 4 shows a piece of steel from such a composition which is very fine-grained for a large rail, tough, and has a tensile strength of 120,000 to 130,000 in the head, the elastic limits ranging from 60,000 to 65,000 pounds. Such rails can be produced commercially, the cost only being increased about one-tenth above the cost of ordinary rails.

Without microscopic examination it is difficult to see why it is so important to make the rails of fine texture and high elastic limits. If a rail simply had to perform the functions of a girder, we could increase its dimensions so that it would have ample strength, even though the elastic limits of the metal were low. But the upper surface of the rail must also act as the infinitesimal rack by which the drivers secure their adhesion for locomotion. Tracing these matters out more fully, we find the metal, in the head of the rail under a driver, in *compression* to the vertical axis of the section, while the metal under the neutral axis would be in *extension*, which would reach to each tie, beyond which, as far as affected by the weight of that driver, the base would be in compression and the head in extension. These strains would be reversed as the driver or wheel reached the next tie space. The metal in the head directly under the wheel must not only bear the weight upon the driver, but also all the traction the driver is exerting to draw the train. From the small areas in contact, the ratio of pressure is from 60,000 to 80,000 pounds per square inch, while the traction often amounts to one-half as much for the surfaces in contact as longitudinal strain upon a thin layer of surface metal in the rail head. Examining the rails in the track with the microscope, we find not only small portions of the metal torn out, but a series of minute cracks, showing that

the metal has been strained upon the surface beyond its elastic limits, and surface wear of metal rapidly occurs. To check this wear we need high elastic limits of the metal for the surfaces in contact. The metal in the tires of wheels abrades on the surface and also drops out in patches, as may be seen in specimens Nos. 3 and 4.

It will be readily understood that, while it is desirable to have sufficiently high elastic limits in the steel to keep the section from taking permanent set under the loads or trains, it is necessary to have high elastic limits in the metal to resist wear. Steel of .35 to .40 carbon has elastic limits in the head varying from 38,000 to 45,000 pounds per square inch, and even then, in the thin-flanged rails, is liable to be brittle. In steel like that shown in specimen No. 4 the elastic limits range from 60,000 to 65,000 pounds in the head, and it is tough in the sections in which it is used. In the 75-pound section, into which several thousand tons have been rolled, the rails are exceptionally tough, exceeding, so far as any records have been published, any tests which have been made. In the 95-pound rails, into which many thousand tons of high carbon metal have been rolled, they are much tougher than was supposed possible to make such large sections. The tendency of improvement in quality of steel is now the production of a fine texture having high elastic limits and considerable percentage of elongation before the full limit of tensile strength is reached. Specimen No. 5 shows the end of a tensile specimen of 53,470 pounds elastic limit and 23 per cent of elongation, the fracture fine and silky, showing at once that it was a tough piece of metal. No evidence of coarse crystallization on the interior of the specimen is to be seen, portions of the matrix penetrating and pulling out from the interior of all the crystals. This steel has been worked to make a fine texture. Specimen No. 6 is from the side of specimen No. 5, and shows on the exterior a tendency to separation on the outside surface of the original large crystals as soon as the steel has passed the elastic limits. On the interior, each crystal being surrounded, greater flow or distortion takes place before separation. This specimen will also serve to better illustrate my remarks about the necessity of high elastic limits in surface of the rails to resist wear.

PROCEEDINGS.

Meeting of April 3d, 1891.

The President, Mr. P. H. Dudley, in the chair.

Twenty-one persons present.

Mr. A. Woodward, chairman of the Committee on Annual Reception, reported the action of the Committee, and the favorable response of the members of the Society, indicating the prospects of a successful Reception.

On motion it was resolved : That the Committee on Annual Reception invite dealers to exhibit instruments and apparatus at said Reception.

Mr. Stephen Helm, F.R.M.S., delivered the fourth and last of his series of addresses on the lower forms of animal life, entitled "Polyzoa and Hydrozoa." This address was illustrated by an extended succession of beautiful, enlarged diagrams, prepared by Mr. Helm, and also by objects exhibited under microscopes as stated below.

OBJECTS EXHIBITED.

1. *Hydra viridis* : by Stephen Helm.
2. Statoblasts of *Pectinatella magnifica* : by Stephen Helm.
3. *Plumatella repens* : by Stephen Helm.
4. *Bugula avicularia* with "bird's-head processes" : by Edw. G. Love.
5. *Bicellaria tuba* : by Edw. G. Love.

On motion the thanks of the Society were tendered Mr. Helm for his series of interesting addresses.

Annual Reception.

The Annual Reception of the Society was held at the American Museum of Natural History, Central Park, New York City, on the evening of April 17th, 1891.

The exhibits were displayed in the large Hall of the first floor of the Museum.

In the large new Lecture Room, adjoining, three successive exhibitions were given as follows : At 8 p.m., Exhibition of Lantern Slides of Diatoms, by Charles F. Cox; at 9 p.m., Ex-

hibition of Lantern Slides of Photomicrographs, by EDW. G. LOVE; at 10 P.M., Exhibition of a series of Wood Sections, by P. H. DUDLEY.

The projections of these exhibitions were made on two screens by two stereopticons alternately, one illuminated by the electric arc light, under the care of L. H. LAUDY, and the other illuminated by the lime light, under the care of L. C. LAUDY.

The intervals between the exhibitions were enlivened by excellent band music.

The microscopical objects in the large Hall and their exhibitors are herewith enumerated as follows:

OBJECTS EXHIBITED.

1. (In alcove.) Old Microscopes and Objectives: by WM. WALES, J. L. ZABRISKIE, C. F. COX, D. S. MARTIN, and F. D. SKEEL.
2. Prints of Old Microscopes: by E. G. LOVE.
3. (In alcove.) Photomicrographic Apparatus: by L. H. LAUDY.
4. (In alcove.) Section Cutting, illustrated by Apparatus and a selection of Serial Sections, prepared by the Paraffin Process: by L. RIEDERER.
5. (In alcove.) Bacteriology, illustrated by growing cultures and slides: by C. E. PELLEW.

Photomicrography: by E. G. LOVE—

6. (In alcove.) Apparatus and the method of its use.
7. Prints of various forms of Photomicrographic Apparatus.
8. Photomicrographs, and the same with Negatives.
9. (In alcove.) Case, showing specimens of Termites, their destructive work, and portions of their nests: by P. H. DUDLEY.
10. (In alcove.) Case, showing specimens of Fungi and Decayed Wood: by P. H. DUDLEY.
11. (In alcove.) A Series of Drawings of the lower forms of Animal Life: by STEPHEN HELM.
12. (In alcove.) Microphotography, illustrated by Apparatus and Slides: by S. N. AYRES.
13. Attachment to the Turn-Table, with mechanism for driving the same: by F. D. SKEEL.

Instantaneous Photomicrographs: by J. M. STEDMAN—

14. Colony of Vorticellidæ, from life.

15. Group of Nais in rapid motion.

Foraminifera: by A. WOODWARD—

16. *Haliphysema Tumanowiczii*, Cornwall, Eng.

17. *Faujasinao carinata*, Cornwall, Eng.

18 Specimens from Chalk, Island of Rügen.

19. Specimens from all parts of the world, and a selection from the collection of the American Museum of Natural History.

20–21. Two Slides, mounted by J. W. Bailey about 1845.

22. Human Flea, *Pulex irritans:* by WM. BEUTENMÜLLER.

23. Eye of House Fly, *Musca domestica:* by WM. BEUTENMÜLLER.

24. Sting of Honey-Bee, *Apis mellifica:* by WM. BEUTENMÜLLER.

25. Scales of various Species of Butterflies, with a collection of Butterflies and Moths from the American Museum of Natural History: by WM. BEUTENMÜLLER.

26. Alloy of Gold, Silver, and Copper: by L. P. GRATACAP.

27. Section of Tulip-Tree, *Liriodendron tulipifera:* by L. P. GRATACAP.

28. Crystals of Sulphate of Copper: by ALFRED BEUTENMÜLLER.

29. Crystals of Bichromate of Potassium: by ALFRED BEUTENMÜLLER.

30. Crystals of Chlorate of Potassium: by ALFRED BEUTENMÜLLER.

31. Vinegar Eels, living: by ALFRED BEUTENMÜLLER.

32. Agatized Wood, enclosing Fungus, Arizona: by THOS. B. BRIGGS.

33. Basalt with Olivine: by THOS. B. BRIGGS.

34. Oligoclase, New York City: by THOS. B. BRIGGS.

35. Hornblende, New York City: by THOS. B. BRIGGS.

36. Foot of Fly: by THOS. B. BRIGGS.

37. Section of Pebble from Chagres River, Panama: by THOS. B. BRIGGS.

38. Sections of Epidosyte, Fibrous Hornblende, Tourmaline, Oligoclase, Mica-schist, and Mica, shown with automatic revolving stage: by JAMES WALKER.

39. Sections of Garter-Snake, embryo, *Eutania sirtalis:* by L. RIEDERER.

40. Sections of California Salmon, embryo, *Oncorhynchus chouicha:* by L. RIEDERER.

41. Marine Crustaceans: by L. RIEDERER.

42. Sections of the Eyes on the Mantle of the Common Scallop, *Pecten irradians:* by L. RIEDERER.

43. Sections of the Eye of the Hermit Crab, *Eupagurus Bernhardus:* by L. RIEDERER.

44. Larval English Oysters, polarized light: by SAMUEL LOCKWOOD.

45. Metal Chips cut from Cover of Box by Mexican Beetle: by F. W. DEVOE.

46. Spider's Silk Compared with 120 Spool-Cotton Thread: by F. W. DEVOE.

47. Section of a Rat's Toe: by CHAS. S. SHULTZ.

48. Platino-cyanide of Magnesium, polarized light: by CHAS. S. SHULTZ.

49. Vase and Bouquet of Diatoms and Butterfly Scales: by MISS M. A. BOOTH.

50. Section of Leaf of Scotch Pine, *Pinus sylvestris:* by GEO. E. ASHBY.

51. Fibre from Fruit-stalk of Banana, polarized light: by E. G. LOVE.

52. Anchors and Plates of Synapta, dark-ground illumination: by E. G. LOVE.

53. Crystallized Tin: by E. G. LOVE.

54. Spiracle of Larva of Dytiscus: by E. G. LOVE.

55. Itch Insect, *Sarcoptes scabiei:* by E. G. LOVE.

56. Gizzard of Cricket: by E. G. LOVE.

57. Arrowhairs of Dermestes: by E. G. LOVE.

58. Luxulyanite, polarized light: by J. W. FRECKELTON.

59. Native Copper, crystallized, Lake Superior: by FREDERICK KATO.

60. Crystals of Black Snake Fat, polarized light: by EDGAR J. WRIGHT.

61. Bacillaria paradoxa, living: by A. G. ROBINSON.

62. Hydra viridis: by T. CRAIG.

63. Section of Echinus Spine and Echinus with Spines removed: by A. H. EHRMAN.

64. The Parasitic Wasp, *Leucospis affinis* Say: by J. L. ZABRISKIE.

65. Fragment of "The Pen" of the Squid, *Loligo Pealei* Lesueur, polarized light: by J. L. ZABRISKIE.

66. Tangential Section of Bamboo: by F. D. SKEEL.

67. Section of Gneiss, Long Island, polarized light: by F. D. SKEEL.

68. Compound Eye of Insect, with multiple images: by J. D. HYATT.

Termites, or so-called "White Ants," from Panama: by P. H. DUDLEY—

69. Eutermes Soldier—entire.

70. Head of Termes—Soldier.

71. Head of Calotermes—Soldier.

72. Worker of Termes minimus Beaumont.

73. Head and Wing of Termes minimus Beaumont.

74. Ovaries, portion, of Eutermes Queen.

75. Circulation of Chlorophyll in Nitella, a fresh-water plant: by STEPHEN HELM.

76. Pond Life: by STEPHEN HELM.

77. Diatom, *Arachnoidiscus Ehrenbergii:* by F. COLLINGWOOD.

78. Cyclosis in Cells of Anacharis Canadensis: by C. F. COX.

79. Section of Serjania (stem), polarized light: by C. F. COX.

80. Section of Skin from Negro, showing pigment cells: by W. H. MEAD.

81. Pond Life: by M. M. LE BRUN.

82. Circulation of Blood in the Foot of the Frog: by JNO. L. WALL.

83. Gold Crystals, Fern-leaf form: by G. S. WOOLMAN.

84. Section of Wood: by G. S. WOOLMAN.

85. Head of Mosquito: by G. S. WOOLMAN.

86. Silver Crystals in process of deposition from Nitrate of Silver: by GEO. C. F. HAAS.

87. Human Blood on Holman's Slide: by F. W. LEGGETT.

88. Pollen of Lavatera, in situ: by H. W. CALEF.

Microphotographs: by S. N. AYRES—

89. Sherman's March to the Sea.

90. Foes or Friends.

91. Portrait of Lady.

92. Portrait of Child.

93. Butterfly Scales (1173) arranged to represent a Vase of Flowers: by C. W. McAllister.

94. Scales of forty varieties of South American Lepidoptera: by J. D. Mallonee.

95. Human Scalp, vertical section showing hair bulbs and sebaceous glands: by H. F. Crosby.

96. Foot of Emerald Spider, *Micromata smaragdula*, by H. Hensoldt.

97. Feathers of Brazilian Humming-bird: by H. Hensoldt.

98. Section of Human Brain: by S. A. Briggs.

99. Daphnia pulex: by O. S. Wilson.

100. Chelifer, Pseudo-scorpion: by Wm. Huckel.

101. Tongue of Honey-bee: by C. W. Brown.

102. Leg and Foot of Honey-bee, showing pollen brushes and pollen in situ: by H. C. Bennett.

103. Human Optic Nerve: by L. Schöney.

104. Phylloxera of Grape Vine: by L. Schöney.

105. Yeast Plant: by A. S. Hunter.

An extended series of Microscopes and Microscopical Apparatus was also exhibited by Meyrowitz Brothers, George S. Woolman, Bausch & Lomb, and Eimer & Amend.

It was estimated that between two and three thousand persons were present during the evening.

Meeting of May 1st, 1891.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Fourteen persons present.

Mr. Sereno N. Ayres was elected a Resident Member.

The Corresponding Secretary announced the donation to the Cabinet of the Society by Miss M. A. Booth of 13 slides of her own preparation—1. Flea of Mouse; 2. Parasite of Barred Owl; 3. Jigger Flea from Florida; 4. Parasite of Snipe; 5. Parasite of Snowy Owl; 6. Flea of Cat; 7. Parasite of Pig; 8. Hairs of larva of *Trogoderma ornata;* 9. Parasite, eggs of parasite, and

hairs of Monkey; 10. Wing of Mosquito, *Anopheles quadrimaculata;* 11. Spicules of Sponge, *Meyenia fluviatilis;* 12. Statoblasts of *Plumatella;* 13. Epidermal organs of *Mentzelia floridanum.*

In addition to the above Miss Booth also donated three photomicrographs, taken by herself—1. Statoblasts of *Plumatella;* 2. Hairs of *Trogoderma ornata;* 3. Hairs of *Anthrenus scrophulariæ.*

On motion the thanks of the Society were tendered Miss Booth for these donations.

The Recording Secretary, Mr. Geo. E. Ashby, announced the receipt, from the Department of Microscopy of the Brooklyn Institute, of tickets of admission and the invitation of the members of this Society to attend the Annual Reception of said Department of Microscopy, to be held in Brooklyn on the evening of the 13th instant.

On motion the thanks of the Society were tendered the Department of Microscopy for this invitation.

Mr. E. A. Schultze announced the intended visit to this country in the approaching fall of Mr. J. D. Möller, of Holstein. During this visit Mr. Möller will exhibit large collections of his celebrated preparations of diatoms. Mr. Schultze referred at length to the famed work of the eminent preparer, and distributed among the members of the Society Mr. Möller's circulars, giving the history and description of his famous type and test-slides.

On motion of Mr. Schultze it was resolved : That the Board of Managers be requested to extend an invitation to Mr. Möller to meet this Society during his proposed visit to this country, at some time agreeable to his own convenience.

On motion it was resolved : That the thanks of the Society be tendered Mr. Morris K. Jesup, President, and the members of the Board of Trustees of the American Museum of Natural History, for the generous manner in which the Halls of the Museum and all accompanying facilities were accorded the Society on the occasion of the late Annual Reception.

On motion it was resolved: That the thanks of the Society be tendered Dr. L. H. Laudy and Mr. L. C. Laudy for their invaluable assistance in the provision and the management of the stereopticon projections; and to Mr. William Wallace, Superintendent of the Museum, for the courteous manner in which

he had assisted the Committee on this same occasion of the Annual Reception.

On motion it was resolved: That the Curator be requested to furnish the Recording Secretary, at intervals, with a list of suitable objects in the Cabinet of the Society, from which selections of exhibits for the regular meetings of the Society may be made when it may be desirable.

The Chairman, Mr. J. D. Hyatt, announced the approaching meeting of the American Society of Microscopists, to be held in the city of Washington on the 11th of August.

OBJECTS EXHIBITED.

1. Jigger Flea from Florida—Donation to the Cabinet and preparation of Miss M. A. Booth: by J. L. Zabriskie.
2. Statoblasts of *Plumatella:* by J. D. Hyatt.
3. Conjugation of *Spirogyra nitida:* by E. G. Love.
4. Photomicrograph of the same: by E. G. Love.
5. Wing of Mosquito from Panama: by T. B. Briggs.
6. Section of Hornblende: by T. B. Briggs.
7. Epidermal organs of *Mentzelia floridanum:* by G. E. Ashby.
8. The cœlenterate, *Obelia commissuralis:* by L. Riederer.
9. *Bugula* sp. with diatoms in situ: by L. Riederer.

Meeting of May 15th, 1891.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Thirteen persons present.

The Corresponding Secretary announced a communication from Mr. K. M. Cunningham, of Montgomery, Alabama, accompanying a donation to the Society of a packet of infusorial earth, an extended deposit of which earth Mr. Cunningham had lately discovered in the neighborhood of Montgomery. The main portion of the communication consisted of the following article, relating to this subject, published by Mr. Cunningham in a late issue of the Montgomery *Advertiser:*

"*Discovery of a New Infusorial Earth at Montgomery.*

Editor Advertiser:

"As a matter of scientific interest to your readers, I would like to make known the discovery of a deposit of infusorial earth,

made on yesterday evening while strolling along the river bluffs, observing the character of the various exposed strata. While in the vicinity of the soap factory I noticed an outcrop of argillaceous earth, which, upon an ocular examination with a small lens, suggested the possibility of its being a fossil earth. On giving it the requisite treatment, I was surprised to find that it proved to be a pure diatomaceous earth, and as it happens to be the first of its kind and character recorded as occurring in the Southern States, I hasten to announce the fact. To convey a popular idea of what the substance is in an economic way, it has the following uses in the industrial arts: under the common name of tripoli it is used in polishing optical lenses of all kinds; next, as the basis of the well-known dentifrice Sozodont; then as an adjunct to nitroglycerin in making the powerful explosive called dynamite; as a silverware-polishing substance known in the trade as electro-silicon; and, finally, as of universal interest as material for microscopic study and research, its value as a microscopic novelty being about one dollar a pound. Incidental to the above points of interest, I would mention that its occurrence adds another component rock to the geological strata of Alabama, hitherto not noticed or mentioned in any work treating of the geology of Alabama. I have barely examined the extent of the thickness of the stratum, but it may have a greater thickness than four feet, and may likewise underlie a very wide area in the vicinity of the hill where its outcrop occurs. A substance similar in its nature and composition occurs in Northern Europe, and is known as 'mountain meal,' and in times of scarcity of food is mixed with wheat or rye and eaten as food. The mineralogical characteristics of the substance are in its being a white clay-like substance, fissile, lamellar; when moistened gives off a clay-like odor and adheres to the tongue; dissolves readily in the mouth, and is pleasant and agreeable to the taste; its mineral composition is practically pure silica; in its microscopic appearance it is a flour composed of millions of minute and very elaborately sculptured silicious, glassy, or transparent shells, associated also with numerous fresh-water sponge spicules, and the absence of all other extraneous vegetable and mineral débris, such as sand grains, etc. The numerous included species are similar to forms already named from localities in the New England States, but an entirely new

source of the material must in the future make Montgomery widely known, as diatomists in all parts of the world will want samples of it for their collections when its fame is spread abroad.

"Dr. Wilkerson, of this city, is the first person who has been able to verify this discovery, as it was first viewed through the microscope in his office. K. M. CUNNINGHAM."

OBJECTS EXHIBITED.

1. Eggs of Bot-fly on horse-hair: by H. W. CALEF.

2. A curious unknown, aquatic, hemipterous larva: by J. L. ZABRISKIE.

3. A bar of Flexible Sandstone from South Carolina: by WILLIAM G. DE WITT.

From the Society's Cabinet:

4. Parasite of Barred Owl.

5. Hairs of larva of *Trogoderma ornata.*

6. Wing of Mosquito, *Anopheles quadrimaculata.*

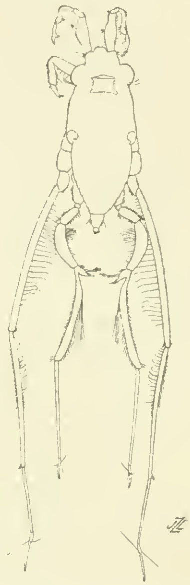
7. Spicules of Sponge, *Myenia fluviatilis.*

8. Parasite, eggs of parasite, and hairs of Monkey.

Mr. De Witt donated his exhibit of Flexible Sandstone to the Cabinet of the Society.

Mr. Zabriskie said of his exhibit that it was captured on July 11th, 1890, in the stream of the Water Works, Flatbush, Long Island. It was at first supposed to be a young larval form of *Gerris;* but it is much more strange in general contour and in curious additions to the appendages than any observed form of *Gerris.* The color is a uniform black, excepting five whitish spots, visible from above—one on the prothorax, two on the outer posterior margins of the metathorax, and two including the posterior coxæ. It has large, four-jointed palpi, the first proximal joint and the fourth joint bearing prongs, giving the appearance of stag horns. When a palpus is deflected the prong of the first joint apparently enters a cavity near the distal end of the third joint, probably forming a prehensile organ. The beak is short, stout, and reclined upon the sternum. The eyes are large and globular. The anterior legs are short and robust. The middle legs are much the longest, being equal to about two and one-half times the entire length of the body from the vertex to the anus. The femur of each middle leg is furnished throughout nearly its entire length with a row of straight, prominent

hairs, about twenty-four in number, averaging in length about twice the diameter of the femur, projecting backward at right angles with the axis of the femur, each hair being slightly hooked at its distal extremity. The tibia of each middle leg is furnished with a row of about sixteen hairs, somewhat resembling those of the femur, excepting that they are shorter, more curved, more prominently hooked, and in that they extend only about one-half the length of the tibia, beginning at the proximal end. The femora of the posterior legs are so curved inwardly that, when opposed to each other, they form a nearly completed circle, and are each furnished with a tuft of stout hairs on their inner opposed surfaces. The tibiæ of the posterior legs are each furnished at the proximal end with a stout projection, turned at an angle inwardly, like the barb of a fish-hook, and each barb is surmounted by a stout, flexuous spine. These tibiæ have also each a slender pencil of long hairs about midway on their inner surfaces, and projecting backward at an acute angle with these surfaces. The last joint but one of the tarsi of the middle legs is furnished with two, and the corresponding joint of the posterior legs is furnished with three, long, diverging bristles. The entire length of the larva, from the curve of the deflexed palpi to the extremities of the long middle legs, when these latter are projected backward, is about three-eighths of an inch, and the length of the body from vertex to anus is a little less than one-eighth of an inch.



Unknown aquatic larva.
Magnified 10 diameters.

Meeting of June 5th, 1891.

The Vice-President, Mr. J. D. Hyatt, in the chair.

Eighteen persons present.

The Corresponding Secretary announced the death of Mr. Charles W. Brown, a Resident Member of the Society.

On motion it was resolved : That this Society has received with sorrow the intelligence of the death of one of its members, Mr. Charles W. Brown, of this city, whose demise occurred on May 19th last, and hereby records this expression of its loss sustained under this unexpected removal of an interested, sympathetic, and faithful attendant at its sessions.

The Corresponding Secretary announced a communication from Mr. K. M. Cunningham, of Mobile, Alabama, dated May 27th, 1891, and accompanying a donation to the Society of a hand-moulded brick of diatom-bearing clay weighing five pounds, which Mr. Cunningham had secured at Apalachicola, Florida, while on a Government survey of the bay, at a point on the bay shore about two miles south from the steamboat wharf at Apalachicola. Mr. Cunningham stated that "the material, on proper treatment, will yield a very interesting showing of 'Gulf Marine Diatoms.'" This "brick" was exceedingly hard, and only after severe labor with a cold-chisel and a heavy hammer were fragments secured, which were distributed among the members of the Society.

The Corresponding Secretary also read a second communication from Mr. Cunningham, dated May 29th, 1891, describing additional donations from him, as follows :

"1. A packet of Foraminifera from rotten limestone, Selma, Alabama. This rock underlies a wide area in the Black Belt, and outcrops at Selma as a bluff fifty feet high and of indefinite length on the river side. If a specimen of this substance be abraded with a tooth-brush, millions of the crystalline microscopic shells are secured.

"2. A piece of the rotten limestone having two sides prepared and polished so as to show the transparent nature of the microscopic shells.

"3. A packet of diatoms from a great spring near Birmingham, Alabama. The diatoms are related to *Epithemia* and *Eunotia*, and are so coarse that they move as freely in the packet as dry sand. They occur *in situ* or parasitic upon a sphagnum moss which grows on the rocky sides of the spring, from the surface down to fifty feet in depth, and are found in long ribbon-like masses, which, under acid treatment, break up into singles, doubles, etc. When the moss is dry a little shaking causes them to fall off, when they can be secured, if desired, by the pint.

"4. A packet of sand from the chert quarries near Birmingham, mainly composed of fragments of silicious, spicular bodies, and curious as a polariscope object.

"5. A packet of microscopic coral from a ledge on the Chattahoochee River at Fort Gaines, Georgia. The ledge is of enormous thickness and extent. The specimens were obtained by sifting the chalky material through gauze.

"6. A packet of fossil granules from a stratum of iron ore, excavated from the tunnel through the Red Mountain. The specimen suggests waste coffee grounds. It is not pretty, but contains a few microscopic snail-like shells.

"7. Fulgorite from a white sand bank at Apalachicola Bay Beach, Florida. If thin fragments of the cylinders are examined, the interior will be seen to be vitrified and polished, and, being full of gaseous bubbles (air?), will show tension colors as a polariscope mount.

"8. My attention having been drawn to certain blister-like blemishes in the oyster shells at Apalachicola, Florida, a brief examination showed that invariably under each blister a small quantity of mud was sealed. Where the inside of the blister did not touch the mud a great array of oyster-shell pearl particles were strewn. Only one side of the blister presents the phenomenon, and it forms an interesting object for the binocular.

"9. Two smoothed fragments of a colossal vertebral joint from the cretaceous formation of Alabama. These specimens, probably from the vertebra of *Zeuglodon*, are curious as being fossil bone. Two of these joints superposed are as large as a month-old baby."

OBJECTS EXHIBITED.

1. Arranged slide of 275 Diatoms from the Sendai deposit, Japan, prepared by Rev. Albert Mann, Jr.: by E. A. SCHULTZE.

2. Section of wood of Hemlock, *Tsuga canadensis* Carr., polarized: by E. G. LOVE.

3. Photomicrograph of *Pleurosigma angulatum*, taken by Dr. Clifford Mercer with a dry $\frac{1}{8}$, air angle 1.40, to show progress made in the manufacture of lenses: by WILLIAM WALES.

4. Larvæ of *Gerris*, of different ages: by J. L. ZABRISKIE.

5. Unknown larva of a Cecidomiid Fly, mining the leaves of the Red Cedar, *Juniperus virginiana* L.: by J. L. ZABRISKIE.

6. Section of eye of King Crab: by James Walker.

Mr. Zabriskie said of his exhibits that these larvæ of *Gerris* are of different sizes and doubtless of different ages, some of them being much smaller and all of them much plainer creatures than the remarkable aquatic larva exhibited at the last meeting.

The larva of the fly mining the leaves of the Red Cedar was taken at Cypress Hills, Long Island, on April 25th last, and was found only on this one occasion. The larva mines the base of the leaf—usually the tenth or twelfth leaf from the tip of the twig—causing an orange-colored, gall-like swelling. The mines are usually scattered and solitary. Only in two instances were larvæ found at the bases of adjoining leaves. The larva is of a bright orange color, about one-sixteenth of an inch long, stout, head very small, and with the junctions of the abdominal rings much constricted. Twenty-two specimens were found upon one small branch of the tree. The larva was submitted to Dr. Charles V. Riley, Entomologist-in-Chief, Washington, and he reported it as "new to the National Collection."

Meeting of June 19th, 1891.

In the absence of the President and the Vice-President, Mr. Anthony Woodward was elected chairman.

Sixteen persons present.

Mr. Ernest Du Vivier was elected a Resident Member.

Mr. George E. Ashby was elected Recording Secretary in place of Dr. Bashford Dean, who was compelled to resign the office on account of the pressure of other duties.

The Recording Secretary read a paper by the President, Mr. P. H. Dudley, entitled "Structure in Steel." This paper was illustrated by six exhibits, as noted below, and is published in this number of the Journal, p. 115.

OBJECTS EXHIBITED.

Six specimens of Rail Steel: by P. H. Dudley.

1. From the tire of a steel wheel; very hard; containing 6% of manganese, and showing the delicate matrix enclosing the pseudo-crystals. Wheels of such steel have given a very large mileage.

2. From a rejected heat of rails. The ingot was maintained at too high a heat in the reheating furnace. Coarse crystals resulted in the head of the rail. In the fracture the crystals have separated from each other without breaking the individual crystals.

3. From the same rail as No. 2, taken near the top of the head. The specimen shows the effect of the mechanical treatment of rolling, which has broken the coarser crystallization, rendering it of very fine texture—practically amorphous.

4. From a fine-grained large rail having a tensile strength of 120,000 to 130,000 in the head, the elastic limits ranging from 60,000 to 55,000 pounds. The specimen contains 60% of carbon, the phosphorus being down to or under .06.

5. The end of a tensile specimen of 53,470 pounds elastic limit and 23% of elongation. The fracture is fine and silky, showing that it was a tough piece of metal. This steel has been worked to a fine texture.

6. From the side of No. 5, showing on the exterior a tendency to separation on the surface of the original large crystals as soon as the steel has passed the elastic limits.

7. Section of ovary of Poppy: by CHARLES S. SHULTZ.

8. Section of English Mistletoe, double stained: by CHARLES S. SHULTZ.

9. Section of scalariform ducts in Tree-fern: by CHARLES S. SHULTZ.

10. Native gold crystals from Catawba Co., North Carolina: by GEORGE E. ASHBY.

11. Malachite from Arizona: by GEORGE E. ASHBY.

12. Section of Luxullianite from Cornwall, England: by JAMES WALKER.

13. Head and mouth parts of *Neris*: by L. RIEDERER.

14. Down feather of Canary Bird: by L. RIEDERER.

15. Transverse section of bud of Lily, of the thickness of one cell of the structure, double stained, having all parts *in situ*, and showing nuclei in all the cells: by ALBERT MANN, JR.

16. Transverse section of the ovipositor of the "Long-Sting Wasp," *Thalessa atrata* Fab.: by J. L. ZABRISKIE.

17. A specimen of *T. atrata*, captured in the act of ovipositing, and having the ovipositing membrane still distended five-eighths of an inch in diameter by the internal coils of the bases of both

the ovipositor proper and the guiding sheaths: by J. L. ZABRISKIE.

Referring to his exhibits, Mr. Zabriskie said that the ovipositor proper of *Thalessa* corresponds with that of *Cryptus* and all its near relatives (see Mr. Riederer's drawings, this JOURNAL, vol. vi., Plate 25), being composed of three main pieces firmly interlocked, but sliding upon each other throughout their entire length. The dorsal piece is the largest. It is solid at the back, nearly cleft in twain from beneath, allowing elastic expansion as of a spring hinge, and having a "tongue" at the middle of either side of the base. The two ventral pieces are counterparts of each other, each being provided with a groove for interlocking with and sliding upon the respective tongues of the ventral piece.

The best published account extant of the oviposition by *Thalessa* is that by Dr. Charles V. Riley in *Insect Life*, i., 172. He shows that the operation is somewhat as follows: The insect stands high upon its feet. The abdomen is raised in the air at right angles with the thorax. The ovipositor, five inches long, more or less, is managed by some of the feet, and its point is brought to bear upon the wood of the tree. The halves of the sheath do not enter the wood with the ovipositor proper, but are used as props and stays for the boring tool during the operation. By a movement from side to side and by bearing upon the ovipositor, the insect gradually forces back the base of the ovipositor proper through the tip of the abdomen into a membrane which issues between the sixth and seventh joints dorsally. There is a wonderful muscular power in the anal joints, and the ovipositor is forced back until it forms a perfect coil, so that, when the abdomen is stretched in a straight line to its utmost, the ovipositor within the membrane makes a circle almost as large as a quarter of a dollar, the anal joint having made a three-fourths turn within the membrane. During this operation the halves of the sheath, which have not followed the ovipositor within the membrane, have been obliged to make a more or less irregular coil opposite to and in front of the membrane on the ventral side. As the ovipositor enters the wood the abdomen descends, the distended membrane gradually subsides, and the halves of the sheath make larger and larger loops above the abdomen. In withdrawing the ovipositor the reverse action takes place, and

the loops of the sheath gradually become smaller and smaller, the ovipositor proper is again forced back into the tough bladder-like membrane between the sixth and seventh joints dorsally, and there is a repetition of the appearance already described.

The specimen exhibited was captured with some others at Flatbush, Long Island, on the 8th of June instant, ovipositing in the languishing portion of a Red Maple tree extending about four feet above the surface of the ground. The ovipositor was nearly withdrawn from the wood, and the membrane was distended in a thin translucent disc fully three-fourths of an inch in diameter. The insect died in the cyanide bottle before the membrane was entirely retracted, and the disc remained as now seen, about five-eighths of an inch in diameter. The specimen shows the curious fact, contrary to the published descriptions, that in this case at least the bases of the halves of the sheath, together with the base of the ovipositor proper, are forced back into the distended membrane, and that the specimen died and has remained with all these parts in this position.

On the 2d of June a German laborer named Schoeffer, a robust, healthy man, part of whose duties consisted in the care of the grounds where the Maple tree is situated, was passing the place, when he was surprised to see one of these "Long-Stings" suddenly descend and strike him upon the bare arm about three inches above the wrist. The blow felt like the prick of a pin. The insect was brushed off and arose among the foliage. Presently the affected spot itched severely and was scratched with the finger nail, when a small blister appeared, which in turn was opened with a pocket knife. Nothing more was thought of the occurrence, but that night Schoeffer walked the floor, being unable to sleep on account of violent pains shooting up the affected arm. The attendance of a physician was sought, and for four or five days intense pain, great swelling involving the entire arm, the axilla, and a portion of the side of the body, gave symptoms of a severe case of erysipelas. On the 8th of June he was seen at the office of his physician, having the arm dressed. The swelling was much reduced, and the affected spot was an open sore in the summit of a protuberance measuring about one and one-half by three inches, and discharging copiously. No theories or arguments, however able or subtle, concerning con-

taminated finger nails and knife blades will ever avail to weaken the conviction of Schoeffer that the sting of the curious insect alone was the occasion of a very close call for the loss of his arm and perhaps for the loss of his life.

PUBLICATIONS RECEIVED.

American Monthly Microscopical Journal: Vol. XII., Nos. 6—9 (June—September, 1891).

The Microscope: Vol. XI., No. 11 (July, 1891).

Journal of Mycology: Vol. VII., No. 1 (September, 1891).

Botanical Gazette: Vol. XVI., Nos. 6—9 (June—September, 1891).

Bulletin of the Torrey Botanical Club: Vol. XVIII., Nos. 7—9 (July—September, 1891).

Anthony's Photographic Bulletin: Vol. XXII., Nos. 12—18 (June 27—September 26, 1891).

West American Scientist: Vol. VII., Nos. 60—62 (May—September, 1891).

Insect Life: Vol. III., Nos. 9—12 (June—August, 1891).

Psyche: Vol. VI., Nos. 183—186 (July—October, 1891).

San Francisco Microscopical Society: Proceedings, June 4—September 16, 1891.

Scientific Association of Staten Island: Proceedings, June—September, 1891.

School of Mines Quarterly: Vol. XII., No. 4 (July, 1891).

Academy of Natural Sciences, Philadelphia. Proceedings, 1891, Part 2.

Journal of Cincinnati Society of Natural History: Vol. XIII., No. 3 (October, 1890); Vol. XIV., No. 2 (July, 1891).

Bulletin of the Essex Institute: Vol. XXII., No. 12—Vol. XXIII., No. 6 (October, 1890—June, 1891).

Proceedings of the Boston Society of Natural History: Vol. XXV., Parts 1, 2 (May, 1890—May, 1891).

Massachusetts Horticultural Society: Transactions, 1889, Part 2.

American Museum of Natural History. Annual Report (1890–91).

Kansas City Scientist: Vol. V., No. 7 (July, 1891).

Central Experimental Farm, Ottawa, Canada: Bulletin No. 11 (May, 1891).

Cornell University Agricultural Experiment Station: Bulletins Nos. 28—31 (June—September, 1891).

Alabama Experiment Station: Bulletins Nos. 25—27 (April, May, 1891).

Iowa Experiment Station: Bulletin No. 13 (May, 1891).

Brooklyn Medical Journal: Vol. V., Nos. 7—10 (July—October, 1891).

Indiana Medical Journal: Vol. X., Nos. 1—3 (July—September, 1891).

Hahnemannian Monthly: Vol. XVI., Nos. 7—9 (July—September, 1891).

The Satellite: Vol. IV. (June—August, 1891), Vol. V. (September, 1891).

Annual of the Universal Medical Sciences: Vols. I.—V. (1891).

American Lancet: Vol. XV., Nos. 302—305 (July—October, 1891).

Johns Hopkins University Circulars: Vol. X., No. 91 (July, 1891).

Electrical Engineer: Vol. XI., No. 164—Vol. XII., No. 178 (June 24—September 30, 1891).

National Druggist: Vol. XVIII., No. 7—Vol. XIX., No. 7 (April 1—October 1, 1891).

Mining and Scientific Review: Vol. XXVI., No. 24—Vol. XXVII., No. 12 (June 18—September 24, 1891).

Le Diatomiste: No. 6 (September, 1891).

Journal of the Royal Microscopical Society: 1891, Parts 3, 4.

International Journal of Microscopy and Natural Science: Vol. I., Nos. 7—9 (July—September, 1891).

Journal of the Quekett Microscopical Club: Vol. IV., No. 29 (July, 1891).

Manchester Microscopical Society: Transactions and Report (1890).

The Naturalist: Nos. 192—194 (July—September, 1891).

Grevillea: No. 93 (September, 1891).

North Staffordshire Naturalists' Field Club: Annual Report (1891).

Bristol Naturalists' Society: Proceedings, Vol. VI., Part 3 (1891); Annual Report (1891).

Penzance Natural History Society: Report and Transactions (1891).

Nova Scotian Institute of Natural Sciences: Proceedings, Vol. VII., Part 4 (1890).

Canadian Record of Science: Vol. IV., No. 6 (April, 1891).

Ottawa Naturalist: Vol. V., Nos. 4, 5 (July, August, 1891).

Royal Society of New South Wales: Journal and Proceedings, Vol. XXVI., Part 2 (1890).

Victorian Naturalist: Vol. VIII., Nos. 1—3 (May—July, 1891).

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